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MECHANICS' REGISTER.

APRIL, 1840.

Practical and Theoretical Mechanics and Chemistry.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Remarks on the Combustion of Charcoal in close rooms, and its deleterious Effects.

The frequent occurrence of fatal accidents, from the combustion of charcoal in close apartments, and the apparent prevalence of the idea, that a deleterious action on the animal system is peculiar to that kind of fuel, has induced me to offer, through the pages of the Journal, a few remarks intended to give a correct notion of the subject, in a popular form.

Every one who has given any attention to his own sensations of existence, is doubtless aware, that life is continued by the act of breathing. This operation is carried on by the muscular action of the chest; whereby a portion of air is drawn into the lungs, and again expelled, after imparting to the blood through the tissues of the lungs a portion of one of its constituents. The constituent which is the useful agent in this process, is termed by chemists oxygen, and sometimes vital air, it forms one fifth part of the atmosphere; the other four fifths being azote or nitrogen, with a small admixture of other gases. The oxygen alone, is necessary for respiration, the azote serving merely to dilute and diminish the activity of the vital air. By a process not yet clearly explained, oxygen imparts to the blood a renewed fitness for the maintainance of life, and is essentially necessary for that purpose; if an animal is deprived of oxygen for a short time it dies. Death by drowning is occasioned by the exclusion of oxygen from the lungs by the water, and may be produced by immersing the mouth and nostrils only; thus a man may be drowned in a single gallon of water.

This brief sketch of the process of respiration may serve to render intel-

ligible the cause of suffocation by the fumes of burning fuel. Whenever any combustible body is set on fire, the whole or a considerable portion of it unites with the oxygen of the atmosphere, and forms various gases differing according to the nature of the combustible, but all alike unfit for respiration; some of them, such as the gases produced by burning sulphur or phosphorus, being actively poisonous, will destroy life even when largely diluted; these give ample notice of their presence by their irritating action, and danger is avoided by timely escape. There is another large class of combustibles which produce a gas unfit for the support of life, but which not being acrid or poisonous does not give warning of danger. These have carbon as their base; they include wood, charcoal, anthracite, bituminous coal, coke, oil, illuminating gas, and in short all the materials in ordinary use for producing light and heat.

Every pound weight of the carbon contained in these substances, requires for its perfect combustion two pounds, or about 200 gallons, of oxygen, and produces about the same volume of carbonic acid gas, or fixed air. As above stated this gas is unfit for respiration, and if the mouth and nostrils of an animal be immersed in it for a short time death ensues. The same gas is found sometimes in coal pits, and is there known by the name of choke damp; it is also found at the bottom of deep wells, especially if they are dry; and in brewers' vats. Its presence may easily be detected by introducing a lighted candle into the suspected place; if the air is pure, the candle burns freely, but if largely contaminated with carbonic acid, it will be instantly extinguished. The gas may be displaced and absorbed by throwing in clear water, or what is still better, a dilute mixture of lime and water. As carbonic acid is heavier than atmospheric air of the same temperature, in the proportion of 3 to 2, it always, when cold, occupies the lower part of the apartment or vessel which contains it, and may be poured from one vessel to another like water. A curious example of this is shewn in the grotto Del Cano, in which a dog is speedily deprived of life, while a man, whose mouth is above the stratum of heavy gas, may enter with impunity. It may be asked, why if wood and bituminous coal produce carbonic acid, do we not hear of persons being injured by them, as well as by charcoal. The reason is simply this; the former contain in addition to carbon and earthy matter, several volatile ingredients, which are given out during combustion, and affect our senses so unpleasantly that we cannot endure the fumes long enough to be seriously injured, but are driven out before the oxygen of the apartment is exhausted.

In order to determine the best means of avoiding danger from burning carbon in an inhabited apartment, we must first take a hasty view of the circumstances attending the process. When the carbonic gas is first evolved, its temperature is raised by the heat of the fire considerably above that of the surrounding air; this increased temperature diminishes the density of the gas in the proportion of $\frac{1}{300}$ th of its density at 52° Faht. for each degree of that scale. Thus, if the temperature of the air should be 52°, and that of the gas evolved 552°, the specific gravity of the latter would be only $\frac{3}{4}$ that of the former, and it would tend to rise with a force varying with the height of the heated column. If, therefore, the combustion takes place in a close apartment, the carbonic gas would first rise to the ceiling, and remaining there until it was cooled nearly to the temperature of the air, it would afterwards sink to the floor and there remain. From this it will be perceived that no portion of such an apartment would be safe; the noxious influence invading successively all parts from the ceiling to the floor.

But if the fire be placed at the lower extremity of a vertical tube or channel leading out of the apartment, the rarifaction of the gas by heat causes it to expand within the tube, and the column within being lighter than the corresponding column without, the former is forced up by the colder air which rushes in to maintain the equilibrium. This is precisely the action of a common chimney, which may be termed a self-acting ventilator of the most perfect kind. Two circumstances are requisite to render the chimney effective, first the fire should be so nearly beneath it, that it may become heated; and secondly, there must be some other openings in the apartment for the admission of air; the latter are usually found in sufficient abundance in the crevices of the doors and windows, and the former is attained by making the fire in the fire-place, or in a stove connected with the chimney or pipe.

Unless both these conditions are satisfied, neither a fire nor a large light should be kept burning in the apartment.

The danger arising from carbonic gas is somewhat increased by its peculiar preliminary effects; when a person is in an apartment in which it is generated and gradually diffused, as from burning coals, or a light, the mingling of successive portions of it with the air produces a gentle lethargy, which is so far from being unpleasant, that the subject is inclined to resist any attempt to arouse him, and if not forcibly rescued will speedily sink into the repose of death. In cases of suspended animation from this cause, life may often be restored by timely application of cold water to the face, exposure to a current of fresh air, or fanning, with the occasional application of spirits of hartshorne or camphor to the nostrils, the camphor in particular I have seen used with excellent effect. C.

Physical Science.

Association of American Geologists.

At a meeting held at the rooms of the Franklin Institute in the City of Philadelphia, on the 2d of April, 1840, the following gentlemen were present, viz:

Edward Hitchcock, Amherst, Mass.; Lewis C. Beck, New Brunswick, N. J.; Henry D. Rogers, Philadelphia; Lardner Vanuxem, Bristol, Pa.; William W. Mather, Brooklyn, Ct.; Walter R. Johnson and Timothy A. Conrad, Philadelphia; Ebenezer Emmons and James Hall, Albany, N. Y.; Charles B. Trego, James C. Booth, M. H. Boyè, R. E. Rogers, and Alexander McKinley, Philadelphia; C. B. Haydon, Smithfield, Va.; Richard C. Taylor, Philadelphia; Douglass Houghton and Bela Hubbard, Detroit, Michigan.

Prof. Hitchcock was appointed Chairman, and

Prof. L. C. Beck, Secretary.

It was then unanimously resolved to organize an Association to be called "*The Association of American Geologists.*"

After the transaction of business relating to the election of additional members, the time and place for holding the next Annual meeting, &c., several communications were made to the Association and discussions had thereon. The following is a brief abstract of these proceedings.

First Day.—Specimens were laid on the table, of quartz, phosphate and carbonate of lime, having a fused appearance, occurring in St. Lawrence county, N. Y., and some views were offered concerning the causes which have given rise to it. Remarks having been made on this subject by several

other members, it was referred for a full report at the next meeting of the Association.

Specimens were next presented, of the sandstones of Massachusetts, exhibiting the fossil footmarks, so called, and some observations made in regard to them. This subject was of so much interest as to induce the Association to appoint a committee to visit the localities and to report their conclusions at the next meeting.

After this, followed a discussion on the subject of Diluvial Action, in which several members took part. Information was communicated concerning the diluvial grooves or scratches which are observed in the valleys of the Hudson, Ohio, and Mississippi,—the polished limestones of Western New York,—the erratic blocks found in New York, Pennsylvania, &c., and several points were suggested for future investigation.

Second Day.—The first business was a lecture on some parts of the Geology of the state of New Jersey. Upon this, remarks were offered by several members; after which there was presented to the Association,

An outline of the Geology of the state of Michigan. The remaining part of the day was spent in free conversation on various geological subjects.

Third Day.—The meeting was opened by some remarks on the apparent Stratification of Serpentine. A locality was referred to in the state of Pennsylvania where that rock exhibits the appearance of being regularly stratified. Several members presented facts concerning other localities bearing upon the question of the origin, whether strictly intrusive or metamorphic, of certain belts of Serpentine.

A statement was made in regard to the frequent occurrence of Fossil Infusoria in almost every town in New England in which primary rocks prevail. A member remarked that after the most diligent search he had been unable to detect them in the Cretaceous Group. After remarks by several other members, the conclusion was, that so far as Fossil Infusoria are known in this country, they are confined to the primary formations.

A notice was next presented of the occurrence of the Native Black Peroxide of copper on the shores of Lake Superior. This was followed by remarks upon the copper ores of New Jersey.

Some observations were then made regarding the Coal Fields of Pennsylvania, particularly with reference to certain changes in the chemical composition of the coal as we proceed from the east to the west. Statements corroborating the general correctness of the views presented, and extending the same to Ohio and Illinois, were made by other members.

Some suggestions were next offered concerning the fertilizing properties of Mica. These led to some remarks on the cause of the fertilizing powers of the green sand, the peroxide of iron, &c.—when it was

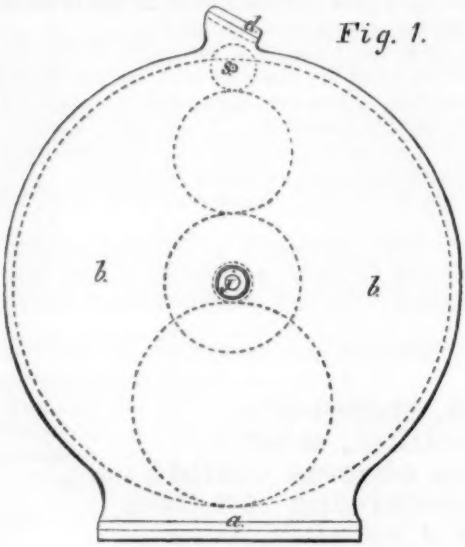
Resolved, that the subject of Mineral Manures be open for discussion at the next meeting, and that the members be requested to note all such facts as may contribute to its elucidation.

Professor Silliman was then unanimously elected chairman for the next meeting, and the present chairman was requested to open that meeting with an address.

The secretary was requested to prepare an abstract of the proceedings of this Session of the Association for publication in the American Journal of Science, and in the Journal of the Franklin Institute; when, after the usual resolution of thanks, the Association adjourned to meet in Philadelphia on the first Monday in April, 1841. LEWIS C. BECK, *Secretary.*

***Description of an Optical Machine exhibited by* Mr. Rd. Roberts, *of Manchester, to the members of the British Association, at the meeting of that body in Dublin, in the year* 1835.**

Fig. 1.



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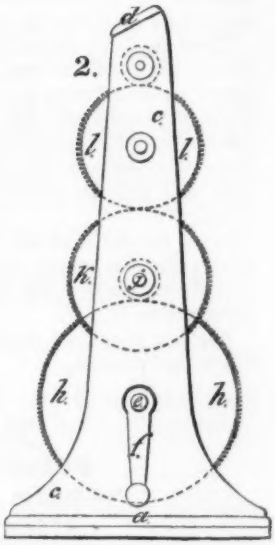

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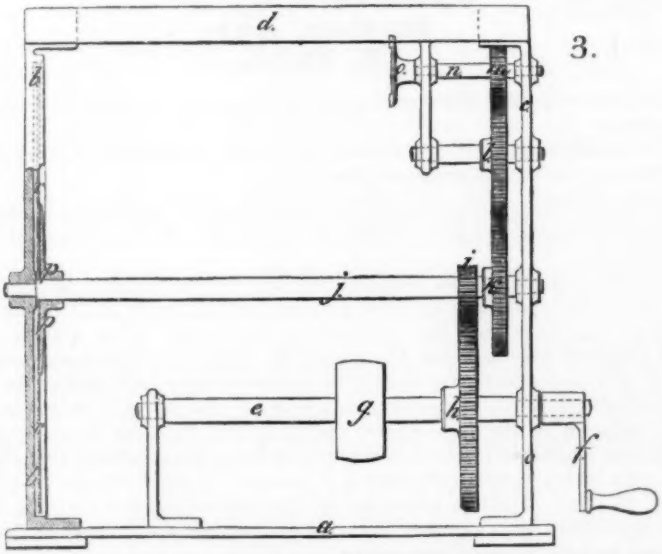


a, is the base plate, to which a plate *b*, and an upright arm *c*, connected with each other at the top by a cross-piece *d*, are bolted, forming together the frame of the machine.

e is a shaft, to which rotary motion may be given by the handle *f*, or by a strap from a steam engine, passing over a pulley *g*,—*h*, a toothed wheel gearing into *i*, a pinion on the shaft *j*,—*k*, a wheel on the same shaft gearing into *l*, an intermediate wheel that takes into the pinion *m*, on the spindle *n*, —to one end of which is secured a plate *o*, dovetailed on its face to receive and hold a card firmly, whilst the spindle revolves rapidly.

To one end of the shaft *j*, is attached a plate *p*, and to this is riveted a disc *r*, of thin sheet iron, which, when the machine is in motion revolves freely within a flanch on the plate *b*. (This flanch is merely to prevent accidents to persons who may be about the machine.) In the plate *b*, opposite the centre of the spindle *n*, is a circular aperture *s*, about $\frac{3}{8}$ of an inch diameter, and opposite to this aperture there is an oblong hole in the disc *r*, about $\frac{1}{4}$ an inch long in the direction of the disc's diameter, and $\frac{1}{16}$ of an inch broad.

After the machine had been briefly explained to the section, it was placed in an anti-room where it remained during the meeting of the Association, that the members might have an opportunity of witnessing the phenomenon presented by it.

For this purpose a card 3 inches long by 2 inches broad, on the front of which was printed,

R. Roberts's Machine, which renders objects visible while revolving 40,000 times a minute, was examined by Dr. Dalton, Jan. 9, 1835.

was fixed to the face of the disc *o*, as the subject to be read while revolving rapidly.

Note—Several hundreds of these cards were distributed, having printed on the reverse the following explanation.

"When a firebrand is whirled in the dark, round a centre in a plane perpendicular to the eye of the spectator, it presents the appearance of a luminous circle.

"From this fact it has been infered that the impression on the retina, made by the luminous body in its passage through every point of the circle, remains until the body has completed a revolution. How rapidly soever the firebrand may be made to revolve, the circle, and therefore, every part of it, will be distinctly visible: hence, a probability arises, that at the greatest attainable velocity, a perfect impression of the object in motion will still be produced on the optic nerve; providing that the time of viewing such object be limited to that which is required for passing through a small space —small, at least, with reference to the size of the revolving body—and also that no other object be presented on the field of vision before the former spectrum shall have vanished from the eye, unless in the case of the same object under similar circumstances.

"The former of these conditions is provided for in Machine No. 1, in which the eye-hole is made to travel through 180 feet between every two

inspections of the moving object, and which object is made to assume a different position at each successive inspection. The latter condition is included in Machine No. 2, the object is there presented to the eye in one position only. RD. ROBERTS."

("Objects may be distinguished in the 150,000th of a second.")

On this card two machines are referred to, but as there was a great similarity between them, it has been thought unnecessary to describe more than Machine No. 2.

The machine was adapted for being turned either by hand or by other power, and in the absence of other power the parties wishing to witness the effect of the machine turned it for each other. Although in this manner few persons could give to the card a velocity of more than 6 or 8 thousand revolutions in a minute, yet as it was read with ease at these velocities, persons generally were disposed to be of opinion that there is no attainable velocity at which objects may not be distinguished.

Subsequently to the printing of the card, but before Mr. Roberts took his machine to Dublin, he had proved that the same card might be read whilst revolving 40,000 times a minute.

The time for each view of the card whilst turning at that velocity, does not exceed the 150.000th of a second.

This machine, therefore, shews that small print may be read on objects passing before the eye with the velocity of a ball when leaving the mouth of a cannon.

Notices of the Weather, and Meteorological Observations, made at Nashville, Tennessee. By PROF. J. HAMILTON.

TO THE COMMITTEE OF THE FRANKLIN INSTITUTE ON METEOROLOGY.

Gentlemen,—I send you another quarterly sheet, in which may be found observations on the late equinox, similar to those of Dec. 21st, 1839. In connexion with them a few remarks upon the weather of the last three months, may not be unacceptable. The winter began earlier and continued with more uniformity than is usual in this region. Its average temperature was 38°.65. The deep snow of Dec. 30th and 31st, 1839, was succeeded on the 5th of Jan. by a thaw, with warm rains and a very dense fog, which continued several days. The temperature of the month was afterwards low until the 26th day. After four days of mild weather a change took place again, preceded by a thunder storm on the 29th, which was followed by a fall of snow to the depth of 2.5 inches, commencing on the 31st, at 4 P. M. The minimum temperature of Jan. was on the 2nd day when the Thermometer was as low a +5°, but rose to 42° at noon. The minimum on the 16th, 17th, 18th, and 19th days was respectively + 11 — + 11 — + 16 and + 6. Comparing these facts with observations in Philadelphia, you will perceive that the cold does not always advance upon us from the east. Maximum temperature of Jan. 65° on 29th—Minimum + 5 on 2nd—Range 60. Maximum of Barometer 30.04 on 25th—Minimum 29.18 on 29th—Range .86. Mean temperature of the month 34.85—Mean of Barometer 29.625—Rain 3.05 inches. The temperature of Feb. was generally mild. The second day was the coldest, when the minimum was + 4° and the mean of the day + 18°. A thunder storm occurred on the 9th and two others on the 27th—Maximum of thermometer 76 on the 19th, 27th, and 29th days—Minimum + 4° on the 2nd—Maximum of Barometer 30.03 on

the 15th—Minimum 29.12 on the 9th—monthly mean of thermometer 46.92 —of Barometer 29.641. Amount of rain 4.87 inches. Peach tree in blossom on the 27th.

March came in mildly and gave fine weather, with the exception of a few days, until about the time of the Equinox. Thunder storms on the 2nd and 20th days, and another of great severity on the 23rd, during which four buildings in this city, without conductors, were struck by the lightning. Since that time the weather has been marked by great changes. On the 30th there were frequent storms of hail and rain with cold winds from W. and N. W. Much high wind during the month. Maximum of Thermometer 79 on the 18th—Minimum 23 on the 31st—Range 56—Maximum of Barometer 29.83 on the 21st—Minimum 29.10 on the 16th at 6 P. M.—Range .73. Mean temperature of March 54.25—Mean of Barometer 29.453 —Rain 4.05 inches.

As you seem to have forgotten that in my observations the italic *c* denotes *cloudy*, and the roman c *clear*, it may not be improper to state that in the notes on the winter Solstice of 1839, the 24th day only presented a clear sky.

Very respectfully, yours, &c.,
JAMES HAMILTON.

University of Nashville, April 1, 1840.

Meteorological Observations, at the Vernal Equinox of 1840, *made in conformity with the instructions of the South African Literary and Philosophical Institution, at the University of Nashville, Tennessee, in North Latitude*, 36° 09′ 33″, *W. Long.* 86° 49′ 03;″ *by* JAMES HAMILTON, *Prof. Math. and N. Philos.*

March 21, 1840.

	External Therm.	Attach'd Therm.	Barom.			
6 A. M.	34	49	29.82 *c*	W. / N.E. by E.	2	At 6h 50m rain and hail for 10m with gust of wind, which ceased with the rain.
7	32.5	48.5	29.82 *c*	Do	1	
8	32.5	48	29.83 *c*	Do	1	Again from 7h 20m to 7h 45m, during which
9	34	48	29.83 *c*	Do	1	Thermometer fell to 31°.
10	37	47.5	29.85 *c*	Do	1	At 9h clouds begin to break in N. but were
11	41	47.5	29.84 *c*	W. / N.E.	1	dense in S.
12	34	47.5	29.83 c	Do	1	Clouds gradually dispersing, and sun was seen
1 P. M.	45	48	29.81 c	Do	1	through Transit at noon. Clear at 12½h,
2	47.5	48	29.78 c	Do	1	except that a few cirrus clouds stretch
3	49	48.5	29.76 c	Do	1	from W. to E. forming an arch at N.
4	49	48.5	29.75 c	Do	1	
5	48.5	48.5	29.748c	Do	1	
6	47	48.25	29.745c	Do	1	At 1 P. M. cirrus thinner and vertex of arch in
7	45	48	29.74 c	W. / N.	1	N.N.W.; continues to become clearer until at 8, clouds form in the west.
8	43	48	29.74 c	Do	1	At 8h 40m wind 2.
9	42	48	29.742c	N.W.	1	At 9h vertex of arch in N. W.
10	40.5	48	29.76 c	Do	1	10h a thin stratum of clouds in W.
11	39	47.5	29.74 c	Do	1	10h 40m the same continues but is higher, and two others appear in the east.
12	36	47	29.70 c	N.W. / N.E.	1	Dew point at 3 P. M. 33°.

March 22.

1	A. M.	36	46.5	29.68	c	$\frac{\text{N.W.}}{\text{E.}}$	1	Vapours collect and form the nebulus about 3 A. M.
2		36	46	29.70	c	$\frac{\text{N.W.}}{\text{N.E.}}$	1	
3		35	46	29.68	c	$\frac{\text{W.}}{\text{N.E.}}$	1	
4		34.5	46	29.67	c	Do	0	
5		34.5	45.5	29.67	c	Do	1	
6		35	45.5	29.68	c	Do	1	

Mean time found by Transit and kept by a superior clock. Fahrenheit's Thermometer—Barometer by Dolland—diameter of tube .4 inch, cup 2 inch.; height above ground 38 feet, and 128 feet above low water of the Cumberland river. External Thermometer, 35 feet above ground, north exposure.

On the day preceding the Equinox, double currents of wind were observed, the upper from the west and the under from the east. At sunrise the Thermometer was at 51° and the Barometer at 29.63. Clouds were gathering in the west and continued to become more and more dense until ten minutes past noon, at which time there was a storm of rain and hail, with thunder and lightning, that lasted until 1 P. M. When the storm began, the thermometer was at 45 and had fallen to 39 before its end. The double currents were perceptible, with the exception of a few hours, until the evening of the 23rd when a very violent thunder storm commenced at half-past 8 P. M. and lasted until 10 P. M., at which time the N. W. wind prevailed and blew very violently till sunset on the 25th. The clouds disappeared during the night of the 24th.

The double currents are marked in the table with the upper above a line and the under below. J. H.

Civil Engineering.

A Popular Exposition of the Incorrectness of the Tariffs of Toll in use on the Public Improvements of the United States. By Charles Ellet, Jr., *Civil Engineer.*

[Concluded from Page 172.]

§ 4. *Of the most judicious charge on articles of heavy burden and small value.*

12. I conceive that it is essential to the fulfilment of the condition, that the tax levied on the trade of the line shall be reconcilable with principles of equity, that the charge at each point shall be proportional to the ability of the article to sustain it; and, it fortunately happens, that when the charges are regulated in the mode that will produce the maximum revenue, this condition will be fully satisfied.

We are to understand by the ability of a commodity to sustain a charge for carriage, the difference between the cost of production and the market value of the object. If the article be worth $10 in market, and it costs $6 to produce and prepare it for market, it will sustain any charge for transportation, including both freight and toll, not exceeding $4. But its ability to sustain a charge *for toll only*, depends on the position in which it reaches

the line of the improvement. For, after deducting the cost of production from the market value, the residue may go to bear the whole cost of carriage; but we must still deduct from this residue the charge for freight, to obtain the sum which it will bear to be charged for toll.

If, for example, the above article reach the line at one hundred miles from the mart, and the freight be one cent per ton per mile, the charge for freight will be $1, and this residue will be $3. If it reach the line at two hundred miles, the charge for freight will be $2, and this residue will be $2. If it come on the work at three hundred miles, the charge for freight will be $3, and the residue will be $1; and if it reach it at four hundred miles, the freight will be $4, and the residue will be nothing. I say, therefore, that to make the tax for toll proportional to the ability of the commodity, the charge levied by the State for its passage along

100 miles should be proportional to $3,
200 miles should be proportional to $2,
300 miles should be proportional to $1,

and along four hundred miles it should be allowed to pass free. From which it appears, that *the greater the distance the commodity is carried, the less should be the toll levied upon it.* In short, I propose that the tax should be proportional to the ability of the trade to sustain the charge; and, by such a tariff, to supersede those now in use—by which the tax is *increased* in proportion as the ability of the trade to bear the tax is *diminished.*

13. Now, it may be demonstrated, that when the toll is assessed on this principle, both the tonnage and the revenue will be greater than if the most profitable uniform charge per mile that it is possible to levy were adopted.

But the method of determining this most productive charge, cannot be conveniently pointed out, with a demonstration of its correctness, in a mere popular discussion. I have, however, elsewhere considered the subject in some detail, and have shown that the toll on this division of the trade which will yield the greatest possible revenue, is about *three-eighths* of the charge which would exclude the article from market; or three-eighths the limit of the tax which it would bear.

In the above example, therefore, the charge at

100 miles, should be	$\frac{3}{8}$ of $3, or	$1	$12\frac{1}{2}$
200 miles, should be	$\frac{3}{8}$ of $2, or		75
300 miles, should be	$\frac{3}{8}$ of $1, or		$37\frac{1}{2}$
400 miles,	0		00

The difference between these sums and those above given constitutes the profits of the proprietors.

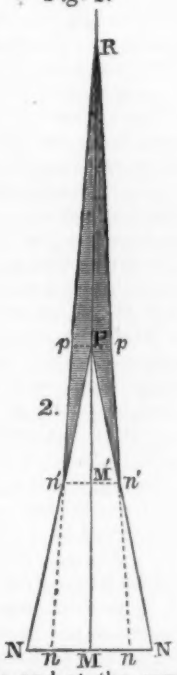
It cannot be objected to this scale of charges, that it deprives the citizen on the line, near the mart, of any of the advantages of his position. The work, on the contrary, furnishes him with the means of transporting the products of his estate to a market for one-fourth, or one-fifth the sum he was compelled to expend before its construction. This is a positive advantage for which he is indebted to the commonwealth; and he has no right to complain, if the same commonwealth extend the benefits of the enterprise to more distant citizens. The avowed object of the improvement is to bring to market productions which could not otherwise reach it, and, generally, to reduce the tax on transportation. And if the objection, that the mode of charging here recommended may seem to disturb the relative advantages of position of the near and distant denizen, be a valid one, it is *a fortiori* a

conclusive argument against *all* improvement. A consequence of the construction of any canal or railroad, is to increase the value of estates to which it affords new facilities, and of course disturb the relation between the advantages possessed by such property and other estates in the commonwealth, on which it has no effect.

But such an objection, even if a legitimate one, cannot be applied to the scale here advised. It is not proposed to tax the distant man less for the transportation of his effects than the nearer one; on the contrary, he is charged more.* The method merely proposes to make that portion of the tax which is to be considered as the profit of the State—that portion which is levied for revenue—proportional to the ability of the trade to pay it. And this is just.

14. If, now, we represent by a proper scale, as in Fig. 2, the area of the country which, with the data of this example, would furnish the tonnage, in the hypothesis of an uniform charge of one cent for freight and one cent for toll, we shall have, as before stated, a triangular figure N P N, with a base, N N, of eighty miles, and height, M P, of two hundred miles.

Fig. 2.



But if the charges were adjusted with a view to the obtaining of the maximum revenue, the triangle would have a base, *nn*, of fifty miles, and a height, MR, of four hundred miles. In the one case the area of the country would be represented by the triangle N P N, and in the other by the triangle *n*R*n*.

15. But, instead of aiming to obtain the maximum revenue on all the trade which would reach the improvement from R to M, we may, by the system which it is intended to recommend, adopt in both instances an uniform charge for toll, as one cent per ton per mile, from M to M′—the point which corresponds with the intersection *n′* of the sides of the superior and inferior triangles—and confine the arrangement made with a view to the maximum revenue, to that portion of the country situated between M′ and R.

The consequence of this arrangement would be to obtain the same tonnage and revenue from the country traversed by the portion M M′ of the line, in both cases, since the tariff would in that distance be common; and at the same

* In the example given in art. 12, as we have seen above, the *toll*

For 100	miles would be	$1	12½
200	"	"	75
300	"	"	37½
400	"	"	00

But the *whole charge*, or freight and toll together,

For 100	miles would be	$2	12½
200	"	"	2 75
300	"	"	3 37½
400	"	"	4 00

or, actually *increasing in proportion to the distance*, and at the rate of 6¼ mills per ton per mile.

time to increase the area of the country trading on the improvement, a quantity equal to the whole of the shaded space in the figure, and to increase the revenue a quantity equal to whatever would be due to this additional trade and the charge upon it, determined in accordance with the principles here laid down.

16. It will be perceived that the increase of tonnage and revenue which, in the preceding article, is shown to have place, will be obtained without any increase of toll on any part whatever of the trade. We have only to take the present tariff of New York or Pennsylvania, or any other state or company, and obtain these results *by a reduction of the charges.*

For, at the point P, which is supposed to be two hundred miles from M, we have seen that a toll of one cent per ton per mile would entirely exclude the trade. But if, instead of a charge of one cent per ton per mile, at that point, or $2 for the entire toll from P to M, the article were taxed but seventy-five cents per ton, as is stated (in article 13) to be the proper toll under the circumstances, there would remain out of the $2, which is the limit of the charge for toll it would bear at that position, a balance of $1 25 to pay the expense of its transportation from *p* to P—a distance of twelve and a half miles on each side of the line. So that, by simply reducing the charge resulting from a tariff proportioned to the distance, we shall here obtain, instead of nothing, a revenue due to the tonnage that would be furnished by a district *p p*, twenty-five miles in breadth, at a charge of seventy-five cents per ton.

It is true that a much more important increase of revenue might be experienced by a modification of the uniform charge supposed to be levied from M to M′, and a reduction from the new tariff beyond M′. For, even where we adopt the principle of fixing on a determinate toll per ton per mile for a certain distance, we should bear in mind that there is a certain uniform charge which will yield a higher result than any other. But, without any reference to this, or any of the other advantages which would be derived from a thorough and strict regard to the laws of trade in the establishment of the tariff, I have only sought to render clear the fact, that by *simple reductions of the charges on a portion of the trade on all our public works, the revenue and tonnage may be simultaneously increased, and the tax on the public may be rendered more equitable.*

17. The preceding conclusions are applicable only to the trade in heavy articles of small value. Equally salutary results might however be obtained by modifications of the charges on the other principal division of the commerce of the country—that which is rendered by its value an object for the competition of rival works. But the examination of the subject with reference to the latter division would, from its complication, be much less susceptible of receiving a popular form. This and other views of the subject, which have always to be considered in any attempt to establish a correct tariff, are examined in considerable detail in my "Essay on the Laws of Trade," where the methods to be adopted to obtain the greatest revenue which the work can possibly extract from the commerce of the country are fully exposed. It is not possible to repeat here, in the narrow space which can now be appropriated to the subject, even the most important of the principles to be regarded in the administration of our public works, which I have there attempted to develope. The glance which is here directed to the question is necessarily confined to a very few prominent points.

To establish a tariff of toll for all articles, on sound principles, requires a certain intimacy with the statistics of the line, and a proper acquaintance

with the laws by which the tonnage and revenue are governed. This knowledge cannot be obtained intuitively; and a correct tariff cannot be devised, as those on all our improvements are, by the mere conjectures of the parties to whose discretion such subjects are usually referred.

§ 5. *General Laws of Trade.*

18. There are some facts of a general character relating to this subject which are susceptible of a most rigorous demonstration, that may be here profitably repeated. It has already been shown that a great loss of trade and revenue is sustained in the management of public works by the adoption of a uniform rate of assessment. In the examples adduced, this results from over-charges, which, under such regulations, invariably have place in some part of the line. It may be shown by a legitimate course of argument, that however we depart from the charge which will yield the greatest revenue, there will be an increase or diminution of tonnage, and, of course, always a decrease of revenue. If the departure be an overcharge, *the tonnage will be reduced a quantity directly proportional to the value of the overcharge, and the revenue proportional to the square of that departure.*

Nothing can prove more conclusively the danger of submitting so important a subject as the preparation of a tariff, to the uncertain guide of conjecture. For, if we err ten mills in the charge which we establish for any article, the loss will be one hundred times greater than if we err but one mill.

19. It is usual to assume that the charge for toll should be proportional to the distance the article is carried—that it should be greater for a great distance than a short one. But we have already seen that, on the contrary, in most cases, *the greater the distance the article is carried the less should be the aggregate toll upon it.* (*Art.* 13.)

20. It is common to suppose either that the tariff of toll is independent of the cost of freight, or that the higher the expenses of carriage the greater should be the charge for toll. But, on the contrary, the fact is susceptible of general and easy proof, that *the higher the charge for freight on the line, the lower must be the toll;* and also that *any increase of the cost of freight will at the same time diminish the toll or profit on the article, and increase the whole tax for its transportation.*

21. The charge for toll is also assumed, in the ordinary establishment of tariffs, to be independent of the mode by which the trade approaches the line; and, for many articles, this is true; but, for others, it is an ascertained fact, susceptible of easy demonstration, *that if they are brought to the work by a common turnpike a higher toll should be charged for their passage on the improvement than if the same articles reach the work by a railroad, and, a fortiori, than if brought by a canal.*

22. Where the object is to obtain the greatest possible revenue, it is a general law, susceptible of satisfactory proof, that *the charge for toll should not exceed half that charge which would exclude the trade from the line.* It may be shown, however, that, although a higher charge than this can never be advantageously adopted, it may frequently be reduced to *three-eighths* of the sum which would cause the exclusion of the trade, with a very beneficial effect on the tonnage, and without leading to any sacrifice on the score of revenue.

23. Another fact, which may be derived immediately from the preceding, is, that *where the most judicious charge is levied, the tonnage of the line will be one-half of the tonnage which would be obtained if no toll at all were exacted.*

24. The charge for toll has already been shown to depend in part on the price of freight; and it is an established law that if the cost of freight be increased or diminished by any modifications of the work, or the system of transportation adopted on it, *the toll must be increased just half as much as the freight is diminished, or diminished just half as much as the freight is increased.* And it is further susceptible of demonstration, that the increase of revenue which will follow a general reduction of the charge for freight *will at least be equal to the arithmetical mean between the values of the tonnage before and after the reduction multiplied by the amount that the freight is reduced.* In other words, if the trade of the line be one hundred thousand tons, and the freight be from any cause reduced $1 per ton, and the tonnage thereby increased ten thousand tons, the revenue of the work will be increased more than $105,000; and this result will have place simultaneously with a reduction of the whole tax on the trade to the amount of $50,000, and the corresponding augmentation of the tonnage.

25. The fact is not usually recognised, that the toll, and tonnage, and revenue, are all more or less dependent on the length of the line of the improvement. It may, nevertheless, be easily proved by a general demonstration, that *the tonnage, the charge which may be levied per ton per mile, and consequently the revenue, will all receive an increase by a reduction of the length of the line of transportation.* So that if the toll be judiciously established on any given line, and any material change of location afterward be made, by which the distance, or cost of freight is diminished, there must be a certain increase of the charge for toll, from which an augmentation of revenue will necessarily result. The value of *this increase of revenue is equal to the whole annual tonnage of the line, multiplied by the actual cost of freight through the distance saved*—and, considering only the value of the trade, it is therefore worth, to reduce the length of the line, the capital of which the interest is equal to that sum.

26. In the arrangement of the charges in a tariff, there is no subject of greater importance, for some articles, than the positive, and for others, than the relative, value of the mart. From the positive value of the article, is determined the tax which one division of the trade can sustain; and from the relative value is in part deduced the proper toll on all commodities for which other works are competitors.

A permanent change of the relative standing of the mart, ought, therefore, to superinduce a modification of the toll. And it may be easily shown that if the relative value of the market—by which is intended its value compared with that of the rival mart—be increased any given sum, we shall find the corresponding increase of toll per mile proper to be made, *by dividing that increase by twice the length of the improvement in miles.* If, for instance, the value of Philadelphia as a mart for tobacco, compared with the value of New Orleans in reference to the same article, be, from any cause, increased $4 per hogshead, and the distance from Philadelphia to Pittsburg be four hundred miles, then, I say, the toll on tobacco on the whole central line of the Pennsylvania improvement, should be increased a half-cent per ton per mile.

It is also easy to demonstrate that, at the same time, *the revenue will be augmented by any increase of the relative value of the market, an amount obtained by multiplying the original tonnage added to half the increase of tonnage consequent on the improvement of the market, by the increased value of the tonnage at the market.*

It is shown, in fact, that whatever circumstance occurs to increase the

value of the property sent along an improvement, to the holder of the property, will cause a certain increase of tonnage, of which the measure can be obtained, and a simultaneous augmentation of revenue equal to the whole increase of its value; and that *whatever unnecessary tax is levied on the trade, is at least so much deducted from the revenue of the improvement.* If, for instance, the engineer in making the location permit his line to be one mile longer than is essential, he will thereby cause to the State or Company an annual tax, or equivalent loss of dividend, equal to the whole annual expense of transporting the whole trade of the country through that mile. He incurs, at the same time, the responsibility of reducing the tonnage of the work, and of injuring, to a certain extent, both the country that supplies the trade, and the emporium which receives it.

If he embarrass the line by an unnecessary grade, or any other impediment which involves a similar increase of the charge for freight, he is responsible for the same result; and, before adopting such a measure, is bound to compare the value of the difficulties to be avoided, with that of these inevitable consequences to the future trade.

28. It is an error, and a very frequent one, to suppose that the toll is in any manner dependent on the cost of the work; or ought, under any circumstances, to be directly proportional to the value of the article. It is, however, not uncommon to assume, that it ought to bear some relation to the cost of construction; and there are tariffs of toll in the data for the calculation of which the value of the commodity is the principal, if not the only element. It is not a little singular that, after encountering an expense of hundreds of millions for our public works, the tariffs by which they are to be sustained should be entirely ruled by considerations which, however plausible in a superficial view, have no legitimate relation to the question.

For one division of the trade, it is not the positive value of the commodity, but the difference between the market value and the cost of production; and for the other, the difference between the value of the article at the mart of the improvement and at that of its rival, by which the toll is influenced. And this influence is only partial. The value of the article, taken in any sense, is only a part of the data by which the true charge must be determined.

29. It is by no means the intention here to attempt a general analysis of this most important subject. My object, as already announced, has been to show that, under certain circumstances, a marked increase of trade and revenue may be obtained on all our public works, by simply reducing the charges; and that such modifications of the tax levied on the community is rendered imperative by the first principles of equity. If I have succeeded in making this truth perfectly apparent, the design of these pages will be fully accomplished.

I scarce hope to have satisfied the reader in a discussion so brief and popular, that to enable a company to take the full advantage of its position, and obtain the highest degree of success of which their enterprise is susceptible, demands a careful and close investigation of the laws of trade in reference to every branch of the subject. To appreciate the importance of this course, requires that the mind should have investigated such questions sufficiently to estimate the consequences of its neglect. To know the value of establishing the most correct tariff, we need to know what we are likely to lose by the adoption of a conjectural or empirical one.

This subject, though usually taken under other auspices, is peculiarly a professional study. An intimate acquaintance with the principles which

govern the trade of an improvement, is a department of knowledge which is essential to the engineer in the location of his line, and the establishment of many of the plans of his work. His first duties, when properly discharged, compel him to become the most intimately acquainted with the productions and statistics of the country, and the information acquired in the accomplishment of these labours, ought to be turned to account in directing the future administration of the line.

The preparation of the tariff is, or ought to be, the peculiar province of the engineer. For, though there may be many considerations of policy, which should have a certain weight with those whose final action is requisite to carry his recommendations into effect—and which may frequently render it advisable to modify the charges which an *à priori* investigation may indicate to be proper, where the questions of trade and revenue only are under consideration,—still, it is not less important that the tariff should first be correct in itself, that some estimate may be made of the effect that will be felt when such political modifications come to be admitted. And, withal, it is difficult to conceive what motives of policy should induce any material departure from those limits which the administration of justice, the promotion of the trade, and the augmentation of the revenue simultaneously recommend.

Philadelphia, November 6th, 1839.

Franklin Institute.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Mr. Edward Clark's process for making White Lead.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination the process for manufacturing White Lead, invented by Mr. Edward Clark, of New York; REPORT,

That it consists in the introduction of vapor of vinegar, carbonic acid and atmospheric air into chambers, which contain sheets of lead either rolled and placed on shelves, or open and hung on slats, the shelves or slats being supported by cleats attached to the posts forming the sides of the chambers, the vinegar is placed in a trough passing through the centre of the chambers and is heated by steam passing through its double bottom. The carbonic acid enters from the fire by which the steam is generated, and this gas, together with air, are forced into the chambers by bellows or from a gasometer. The main points of difference between the present and Richards' process, described in the Journal for 1839, lies in the introduction of steam by the latter into the chambers from above, and in the double walls of the chambers, which receiving steam maintain the inner chamber at a given temperature. Mr. Clarke's patent is dated Dec. 4th, 1828, reissued as amended in July 3d, 1832. Mr. Richards' was obtained a few years since. Between the present and the ordinary processes, the difference lies in the mode of elevating the temperature and generating the carbonic acid gas, which ordinarily are produced by the fermentation of vegetable matter (dung) which generates heat and carbonic acid, and vaporises the vinegar.

A process of a somewhat similar nature is pursued in the south of Germany, the lead sheets being hung on slats, which lie over troughs of about five feet in length, containing, on the bottom, vinegar mixed with wine-lees.

The troughs are piled up in a chamber which is heated by hot air or by steam. The vinegar is vaporised by the heat of the chamber and the carbonic acid arises from the fermentation of the lees. Great care is taken to exclude the atmosphere as far as possible, as it is found to injure the quality of the white lead, a point in which this process differs materially from those of Clark and Richards. The product is the finest quality of white lead in Europe, known as the Kremser white.

The introduction of carbonic acid, generated by the combustion of charcoal, for the purpose of assisting in the formation of white lead, has been practised many years in France in the new method of precipitating cabonate of lead; it has been farther employed in England, and in this country, in the manufacture of white lead. The novelty of Clark's process therefore consists in forcing atmospheric air into the lead chamber; Richards' in the introduction of steam in addition to the preceding; and both possess some claim to novelty in the peculiar arrangements of their apparatus.

The committee cannot draw conclusions relative to the economy of Clark's process nor to the quality of the material produced, as no theoretic grounds will warrant their so doing, but their views on this subject are given more at large in a report on Richards' method published in the July No. of the Journal of the Institute for 1839.

By order of the Committee,

WILLIAM HAMILTON, *Actuary.*

Philadelphia, April 9th, 1840.

Report on Mr. John P. Bakewell's Safety Valve.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a self acting Safety Valve, invented by Mr. John P. Bakewell, of Pittsburgh, Pa., REPORT:

That Mr. Bakewell represents his invention to consist in supporting the fulcrum of the lever of the common safety valve in such a manner that the more it may be loaded, for the purpose of keeping the valve closed, so much the more effective it will be in opening the valve, in case the boiler should become unduly heated.

To effect this object he makes use of a fusible alloy placed in a tube in the manner recommended some years back by Prof. A. D. Bache. (See Journal Franklin Inst., Vol. X, p. 223.)

The stem inserted in the fusible metal, supports the longer arm of a horizontal lever of the first order, the fulcrum of which is fixed in a standard rising from the valve case and extending some distance above the lever, for a purpose to be named presently. The shorter arm of this lever (which for the sake of convenient reference, we shall term the sustaining lever,) carries a short upright bar, on the upper end of which is the fulcrum of the safety valve lever; the latter being a lever of the second order loaded near its extremity in the usual manner.

While the fusible metal remains solid, it keeps the stem and sustaining lever steady, and the apparatus acts precisely like the common safety valve, the loaded lever resting parallel to, and a short distance above, the sustaining lever. But if the metal should be fused by overheating, the stem sinks into it; the short arm of the sustaining lever rises and elevates the fulcrum of the valve lever, the loaded end of the latter descends until the lever comes

in contact with a shoulder on the standard before mentioned. This shoulder now becomes the fulcrum of the valve lever, converting it into a lever of the first order, and the action of the weight with which it is loaded now tends to raise the valve with as much force as it previously exerted in keeping it down. The valve is by these means forced open, and, in the opinion of the inventor, will remove all danger of explosion by giving vent to the steam.

Without undertaking to discuss in this place the propriety of making an opening at such a juncture, the Committee take pleasure in expressing a favorable opinion of the contrivance proposed by Mr. Bakewell, for effecting that object. So far as appears, the arrangement is entirely novel, it is certainly very ingenious, and combines great simplicity with entire efficacy in opening the valve whenever the alloy is fused.

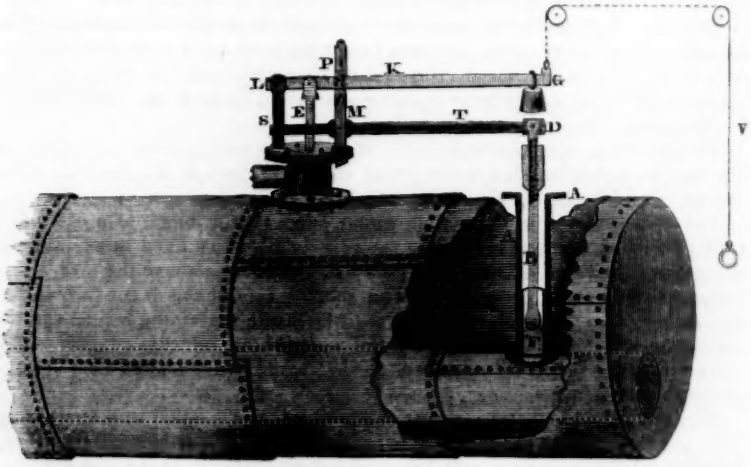
By order of the Committee.

WILLIAM HAMILTON, *Actuary.*

Philadelphia, April 9th, 1840.

Description of the Self-acting Safety-valve, invented by MR. JOHN P. BAKEWELL, *of Pittsburgh. Furnished by the inventor.*

The invention consists in a mode or method of fastening and securing the pivot end, or turning point, of the beam, or lever, of a common safety valve, in such a manner that the heavier the weight may be which is placed upon the opposite or long arm of the lever beam, for the purpose of keeping the valve closed—the more certain and effectual shall be the operation of the apparatus in opening the valve, whenever the boiler shall have been heated to such a degree of temperature as may be considered dangerous, or liable to become so; which may be done as follows, and is best explained on reference to the accompanying sketch or drawing of the same.



A, a metallic pipe or tube, which is to be placed within and securely fastened to the boiler with its lower end resting upon the flue, (or the bottom of the boiler if made without flues.)

B, a metallic rod or stem, constructed with an enlargement at one end, and connected, with a right and left screwed collar, to a piece made with a pivot hole at D.

E, the safety valve, made as usual, GKL lever beam.

F, a suitable quantity of the fusible metallic compound enclosed in a thin metallic cup, which is loosely connected at the top with the rod B, so that it can be taken out of the pipe A, if required, by raising the rod.

ST, a bent lever connected at L with the short end of the lever beam—turning in a slot at M, and connected with the upper part of B at D, and having an opening through which the stem of the safety valve passes freely without touching.

M, a standard or upright attached to the upper casing of the safety valve, and constructed with a slot to admit the free motion of ST, and with cheeks or guides above, which loosely clasp the lever beam; the bottom of which slot is filed to an edge, and is to be about one-half an inch below the bottom of the lever beam, as seen just below *n*.

It will be seen that the fusible metal will sustain the rod B and lever ST, as long as it shall remain unfused, and consequently serve as the support for the pivot end of the lever beam, GKL.

And that as soon as it becomes fused, it will allow of the descent of the rod B, and as soon as the lever beam touches the standard M at *n*, the action of the lever is reversed, and it must exert the same power to open the valve as was before exerted in holding it down.

To replace the apparatus, it will be requisite that whenever notice is given from the escape of steam that the boiler has become so much heated as to fuse the alloy—that the engineer should raise the lever beam by means of the usual lift line V, until it touches a bolt or pin P, which is passed through the cheeks of M, and at the same time withdrawing the stem from the melted alloy, and holding it there until the alloy is sufficiently cooled, either from the escape of steam or from cold water having been poured within the pipe A, so as to enable it to sustain the stem as at first.

The double right and left screwed collar is intended for the purpose of regulating the proper position of the lever ST, and connexion at L.

The claim as inserted in the patent is as follows, viz:

"I claim as my invention, the attachment of a rod or stem (B) to the end of the lever or beam of a safety valve, *in such a way*, that it shall be the fulcrum, pivot, or turning point of the beam, as long as the alloy remains unfused; and, I claim the placing of a standard or upright (M) between the safety-valve and the weighted end of the lever to which the beam shall shift its fulcrum or pivot whenever the alloy shall become fused or melted."

The patent is dated December 21, 1839; application filed in September.

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN APRIL, 1839,
With Remarks and Exemplifications by the Editor.

1. For an improvement in *Church and other Bells, and in hanging the same;* Ebenezer Dewey, city of New York, April 10.

This bell is a cone, a section through the axis of which would present a right angle at its apex, its diameter at its base being equal to twice its height. "The diameter at the mouth of the bell is forty lines, and the

thickness of the lip is one line, and one third of a line in thickness at the top, and half a line in thickness at one third the distance from the base or mouth to the crown, and gradually diminishing in thickness from thence to the crown." These dimensions, it is said, may be changed. This bell is not intended to swing like the ordinary church bell, but it is attached to a cross timber which hangs on gudgeons at its ends to allow a free vibration and motion to the bell. The hammer strikes on its outside, its handle being affixed to a shaft which turns on gudgeons, and which stands parallel to, and above the timber by which the bell is suspended; this shaft has a pulley on its end to which the bell rope is attached, and in ringing, the hammer may be carried clear over from one side of the bell to the other. A spring on each side serves to hold the hammer clear of the bell after the stroke.

Claim.—"I claim the gradual diminution of the thickness of the sides of the conical bell from the lip at its base to its apex or crown, in the manner above described; and also the combination of the yoke and shaft containing the hammer handle and the spring, in the manner and for the purpose above described."

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2. For an improvement in the *Manufacture of White Lead;* Charles Button, of Great Britain, and Harrison G. Dyar, a citizen of the United States, April 10.

This invention is divided into three parts, consisting, first, of a method of purifying the gases and vapours arising from anthracite, stone or mineral coal, or from coke, so that the gases arising from such kinds of fuel may be used in the manufacture of white lead; secondly, in the use of basic nitrates of lead, for making carbonates of lead, and lastly, in manufacturing white lead from litharge, massicot, or protoxide of lead, by boiling nitrate of lead with either of those substances, and submitting such mixture while in a heated state, to the action of carbonic acid gas. The patentees describe the apparatus employed by them, but do not claim this as making any part of their invention. In the London Journal of Arts, vol. xiv, conjoined series, p. 383, there is an account of this patent, as obtained in England, accompanied by a plate showing the apparatus used.

The claims made are, "1st. The acting upon the vapours or gases, arising from the furnace used in the process of making white lead, in such a manner, (by the introduction of atmospheric air, and by washing, hereinbefore described,) as enables us to use that cheap kind of coal, called stone or mineral coal, in the said furnace, and to arrest the smoke and other impurities injurious to the colour or quality of white lead, so that we are enabled to use carbonic acid gas, obtained therefrom, in the process of manufacturing white lead.

"2d. In the manufacture of white lead from such compounds of nitric acid with oxide of lead, in which the quantity of oxide bears a greater ratio to the nitric acid combined therewith, than the oxide of lead bears to the nitric acid in the ordinary nitrate of lead of commerce; and which nitrates we call basic nitrates of lead.

"3d. Making white lead by boiling, as hereinbefore described, or otherwise acting upon the litharge, massicot or protoxide of lead, with either nitric acid or the common nitrate of lead of commerce; and while in a boiling state or otherwise, submitted to the action of, or brought minutely into contact with carbonic acid, in order to produce a pure carbonate of lead; or, as it is usually called, white lead; and in such manner, that the same nitric

acid or nitrate of lead may be used over and over again, many times, with fresh portions of litharge, as hereinbefore described.

"4th, and lastly. The process of further purifying and condensing the white lead obtained as aforesaid, by what we call mashing it, as hereinbefore described."

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3. For a *Washing Machine and Clothes Press;* Jonathan Read, city of New York, April 10.

It seems that there was novelty enough found in this machine to justify the grant of a patent; the whole affair, however, is obscurely described, and very imperfectly represented in the drawings; and after a sufficient examination of the whole matter, we do not think the time and space would be profitably employed in endeavouring to make its structure and operation known. The claim if given, would afford no information, excepting that a certain shaft, handles, wheels, straps and treadles, are to be used.

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4. For an improved *Garden Cultivator;* John Bush Smith, Princess Ann County, Virginia, April 10.

This machine is furnished with teeth, in the manner of other cultivators; its frame is to be supported on two wheels which may be varied in their distance apart by being made to slide on their axle, for the purpose of marking the ground of different widths. It has two handles by which it may be guided, and at its fore part a strip rises vertically, which is furnished with a slot, to enable the person managing the machine to take proper sight. The "claims made, are to the mode of directing the course of the machine by means of the sighting staff, and of adjusting the machine for different widths by shifting the wheels on the axle, as described." The improvements thus claimed appear to be of doubtful originality, as it is no new thing to fix a rod or stick upright in front of an agricultural implement to sight by; we have seen this done many years since, but whether it is a common device we do not know. The shifting of the wheels upon the axle to mark the widths of rows for planting is used in Rockwell's machine, patented on the 12th of March, and described in the last number of this Journal; we believe that this also was no new device.

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5. For *Preventing Injury from the Explosion of Steam Boilers;* Philip C. Friese, city of Baltimore, April 10.

The nature of this invention will be clearly understood by an examination of the claims, which are to "the application to steam boilers of a jacket, possessing in its construction the following three peculiarities.

"First. This jacket must envelope the steam boiler entirely, leaving throughout a certain intervening space between the jacket and the boiler.

"Second. This jacket must have a convenient number of holes in it; each hole to be fitted with pipes bent to whatever direction it may, in each case, be considered most harmless to lead the steam in the event of an explosion of the boiler.

"Third. This jacket must be able to resist, on every square inch of its inner surface, a pressure somewhat greater than the maximum that can be withstood on every square inch of the boiler."

This is a plan that has been often thought of, and often proposed, but we do not recollect that it has ever before been made the subject of a patent. The practical, if not theoretical, objections to it are such as will not admit of

its adoption. The cost of a boiler, and its weight, would be much more than doubled; it would be much less managable than the ordinary steam boiler, and would, from this cause, be more subjected to the influence of those circumstances which produce explosions. As respects "the maximum that can be withstood on every square inch of the boiler," we are not aware that the data are known by which the actual force can be measured to which a boiler is subjected in many cases of explosion; we have not yet determined what, under all circumstances, are the causes of explosions. This well intended effort to lessen the evils resulting therefrom will not, we apprehend, be adopted by engineers.

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6. For *Cutting Coats without back, side, or lapel seams*; William M. Wiswell, Portland, Maine, April 10.

To describe the plan intelligibly, which is the subject of this patent, would require the diagram given in the specification, and the references thereto. With respect to the utility and economy of the plan, we do not pretend to judge. We hope, for the sake of the patentee, that it may prove better than a similar one for cutting breeches, by which we were once, in our younger days, put "in durance vile," until they acquired, spontaneously, some slashes, affording the requisite liberty of motion.

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7. For a *Railway Cooking Stove;* Anson Atwood, city of Troy, New York, April 10.

Without the drawings, the peculiarities of this stove could not be made known. Railway stoves had been previously made, the object of them being to enlarge or contract the dimensions of the apparatus so as to adapt it to the purpose of cooking a larger or smaller quantity, as might be desired. The manner in which the present patentee had constructed his stove was deemed, in the office, to present sufficient novelty upon which to found the grant of a patent, but we are informed that upon a trial in court it has been pronounced to be an infringement upon a plan previously patented.

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8. For a *Corn Cultivator;* John B. Smith, Princess Ann county, Virginia, April 15.

The claim is to "the arrangement of the perforated beams, in combination with the shifting and reversible ploughs, for throwing the earth *from,* or *towards,* the rows of corn, regulated to any required width in the manner described." The two ploughs used with this cultivator are so constructed as that they may be placed nearer together, or further apart. When passing between rows of corn, or other plants, they are placed at such distance as that the horse shall draw them within the rows, and they are so sloped as to throw the earth outwards from them towards the corn. They are calculated also to run on the outsides of two rows, for which purpose they must be removed to a corresponding distance, and so turned as to throw the earth inwards, towards the plants. It is the particular construction by which this change is allowed that forms the subject of the foregoing claims.

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9. For improvements in *Steam Boilers,* and apparatus to prevent explosions thereof; Cadwallader Evans, Pittsburgh, Pennsylvania, April 15.

In the apparatus described in the specification of this patent, there is a very skilful arrangement and adaptation of the respective parts for the pur-

pose of preventing explosions. The fusible alloy is to be used, combined in a particular way with the common safety valve, and in such manner as to leave the valve free to act by the ordinary pressure of the steam; the alloy being intended to regulate the opening of the valve by the influence of temperature alone, irrespective of the pressure of the steam. The claim in this part is to the particular manner in which the combination is made between these parts.

To give notice of the descent of the water to a point below that of safety in either of the outside boilers in a series of boilers like those used on our western waters, a float is so used as to allow of the escape of steam, which is to sound a whistle on one side, and a horn on the other, which shall distinctly indicate the fact, and the boiler in which the water is deficient. The particular combination for effecting this, is claimed.

A water level of a peculiar construction is made so as to exhibit, in the cabin, the level of the water in the boiler, operating by its combination with the other parts of the apparatus in producing this result.

There is also claimed an apparatus for extinguishing the fire, which is made to operate by the fusible alloy apparatus; and likewise an apparatus for preventing the careening of a steam vessel at a pier, wharf, or bridge.

Without engravings, and the whole specification, we could not attempt to make known the nature of these various improvements; it is probable, however, that we shall obtain the means of so doing, and thus lay the whole matter before our readers.

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10. For an improvement in *Water Wheels,* and in the application of Water thereto; Eliza Martineau, administratix of John Martineau, Elbridge, Onondaga county, New York, April 18.

Six, or any other convenient number of buckets, are to be fixed around a shaft, so as to revolve within a drum, or cylindrical case, which they are to fill, in width; the water is to be let in through a spout at the periphery of the wheel, and is to strike against the convex sides of the curved buckets, in order to give the water a tendency to continue near the periphery until it has passed round the circuit of the case; the escape for the water is at the centre of the wheel, which in this respect, and in the manner of letting the water on, resembles the wheel first patented by the late Joel Eastman, and subsequently with improvements, we believe, by Mr. Martineau.

The claim is to "the curved case, the inside of which is in the form of a scroll, in combination with the crooked, or curved, arms, as described."

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11. For a *Press for Hay, Cotton, &c.;* Chas. W. Hawkes, Brunswick, Cumberland county, Maine, April 18.

In this press the follower is to be brought down upon the hay, cotton, or other article contained in the pressing box, by means of a rack and pinion; to which, of course, no claim is made, the claims being confined to certain special arrangements intended to facilitate the operation; these consist in the mode of employing a lever to clear the follower from the interior of the box; a method of fastening the doors, &c.; these may be conveniences in this kind of press, but they do not require special description.

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12. For an improved *Grist Mill;* Oliver Wyman, East Cambridge, Middlesex county, Massachusetts, April 18.

The claims under this patent are to the "perforating the curb obliquely,

in the direction of the turning of the runner, for the purpose of admitting air for the cooling of the meal; and in combination therewith, the wings on the periphery of the runner for producing a draught through the oblique openings in the curb." There has been more than one patent granted for effecting the same object, but by arrangements sufficiently different to admit of the foregoing claim.

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13. For *Propelling Canal and other Boats;* William Leavenworth, city of New York, April 18.

The claim will give a pretty clear idea of the plan of propelling here proposed, which is "by means of an endless chain passing through the bottom of the boat, and resting on the bottom of the canal; its weight forming an anchorage against which any motive power may be exerted for the purpose of propelling the boat by drawing in the chain, in the manner described."

We are convinced that such a mode of propelling will never go into continued practical operation, the constant disturbance of the bottom of the canal would, in itself, be very objectionable; but the lifting and sustaining the weight of the chain would consume too large a portion of the propelling power to admit of its being employed to advantage.

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14. For an improved mode of *Moulding and Casting Water Wheels;* Stephen Parsons, Edgecombe, Lincoln county, Maine, April 18.

The water wheels to be moulded on the plan proposed in this patent, are the "curved vent, or reaction, water wheels." The particular procedure described, in moulding such wheels, forms the subject matter of the claim. A patent having the same object in view, was granted to Calvin Wing, of Maine, on the 22d of October, 1830, which was carried into successful operation. The modes, it seems, were sufficiently different to warrant the grant of the patent to the above named applicant; the matter is not of sufficient interest to require any extended remarks.

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15. For an improved *Plough;* John W. Jordan, Lexington, Rockbridge county, Virginia, April 19.

This patent is obtained for an improvement on the "inverting, hill-side, and horizontal plough," patented on the 28th of October, 1835. The improvements consist in certain devices for adjusting the height of the mould board, in combination with the method described for securing it in place.

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16. For improvements in *Bedsteads;* C. J. Fontaine, J. F. Adams, and G. F. Hillyer, city of New York, April 20.

The claim under this patent is to the dividing the head and foot rails crosswise, in the middle, and hinging them below the division, leaving a lap joint, for the sake of strength. These rails are also hinged to the posts at each end, on their upper sides, "so that when the bedstead is put up and in use, by lifting the end rails at the middle, [after removing the head board] where the joint is formed, the whole may be folded, or closed up, and moved from place to place, without being taken down, or the posts separated."

Where inventions very simple in their nature, appear as the joint production of several intellects, we have not unfrequently been at a loss to say in what way the suggestions made in perfecting the article could be divided into as many parts as there are persons concerned in it. They, however, appear as joint inventors, and we must believe them so to

be. As regards the foregoing invention, it may be useful where bedsteads require frequent removal of place, otherwise we should esteem it no improvement.

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17. For *Glasses and Frames for Spectacles;* Charles L. H. Jackson, city of New York, April 20.

The patentee states that the object of his invention is "to protect the eye from too strong a light as much as possible; and this I effect by leaving only a small portion of the surface of the glasses polished, and surround it with a ground space extending to the circumference, or outside rim, intending to obstruct the passage of the rays of light and soften their effects upon the eye, leaving that portion opposite to the pupil a small, clear, circular space." The bridge, and other parts, are to be so modified as to keep the spectacles steadily in place, as but a small portion of the glass is used for vision; the claims are to the preparing of the glasses, and of the frames, in the manner described.

The convenience, or inconvenience, resulting from the use of glasses thus prepared, and the effects they will produce upon the eye, must be determined by experience alone; our own impressions are that they will be found liable to objections which will prevent their general use.

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18. For an improvement in *Scales for Weighing;* Jonathan Ball, Buffalo, Erie county, New York, April 20.

These scales are of the kind in which the dish to receive the article to be weighed is above the beam. The beam is a graduated rod having sliding weights upon it, by which to ascertain the weight. The arrangement is undoubtedly new, and it is clearly described. The claims are to "the manner of constructing, and combining the balance frame, and movable graduated bars, as above described."

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19. For an improvement in the *Vice;* John Wetherill, Alleghany, Pennsylvania, April 22.

In bench, and other, vices, as ordinarily constructed, the bearing of the screw against the fore jaw, and of the screw box against the back, is constantly varying, as the vice is opened and closed, in such manner as to produce considerable friction; to obviate this, the patentee forms a projection on each side of the centre of the openings in the jaws, which projections are semi-cylindrical, and are received into corresponding hollows on the bearing part of the washer against which the head of the screw works, and also of the screw box; by which means the requisite horizontal vibration is allowed to equalize the bearing, and keep it constantly in the axis of the screw.

The claim is to "the pins, or projections to the cheeks or jaws of the vice, fitting into corresponding hollows on the face of the collar, or washer, of the screw pin; or of pins or projections upon collars fitting into hollows, in the cheeks, or jaws, in such a manner as to form a joint admitting of free motion for the purpose of preventing friction," &c.

A patent was obtained, some few years since, for forming the bearings of the screw, and of the screw box hemispherical, or rather portions of a sphere, received into corresponding concavities in the jaws of the vice; the effect of which is the same with the foregoing.

20. For a *Plough;* William Small, North Argyle, Washington county, New York, April 23.

The claim is to a mode of securing the lower piece of the land side by means of a hook in the fore end, and also to a mode of securing the hind end, in the particular manner described.

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21. For an improvement in *Fire Arms;* David Edwards, Morgan county, Ohio, April 25.

This patent adds another to the numerous family of many chambered fire arms, the novelties claimed relating principally to the manner of causing the many chambered cylinder to revolve, a matter which we shall not dwell upon, as not being likely to excite much interest; the claims would not make the proposed novelties clearly understood.

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22. For a *Horse Power;* William R. Arnold, Rochester, Munroe county, New York, April 26.

A patent was obtained by the above named gentleman, on the 7th of May, 1831, for a horse power, to which the present patent is intended to add certain improvements. These consist in the manner of constructing the cast iron treads upon which the horse is to operate; and in the manner in which these are geared. This arrangement is exhibited in several figures in the drawing, which would be requisite for the explanation.

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23. For a *Tailor's Measure;* Daniel Williams, city of New York, April 26.

The instrument used is the same in construction with that formerly patented by Mr. Williams, but he has added to it certain small pointed hooks which catch upon the coat of the person to whom the measuring instrument is to be applied, and hold it there during the operation; the claim is to these "grapple hooks."

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24. For an improvement in the manner of *Manufacturing the Leaves of Steel Springs for Carriages*; Micah Seabury, Waterville, Oneida county, New York, April 29.

The object in view is to give the proper taper and width, to the leaves of springs, by means of a rolling mill constructed for that purpose. The two rollers are made excentric, to the extent required for the taper of the springs to be rolled; and at the ends of these rollers there are grooves which constitute edging rollers, by which the plates are to be reduced to, and kept at, the proper width. The manner of forming them is fully described in the specification, and the claims made are to "the method described of giving to the metal, to be made into springs, the proper width, in combination with the method of giving the proper thickness and taper." There is but little of novelty in all this, the taper of springs having been given precisely in the manner set forth; but it is not known that they have been rolled to a width on the same rollers.

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25. For *Dressing Sawed Shingles;* Oliver N. May, Windsor, Broome county, New York, April 29.

The difference between this machine and some others for planing shingles, and other articles, is but small, and the claims are confined to those peculiarities by which it is supposed to be distinguished. There is not in it any striking feature requiring to be detailed.

Specifications of English Patents.

Specification of a patent granted to Christopher Nickels, *of the county of Surrey, for his improvements in the mode of manufacturing fabrics from linen, woollen, silk, and other fibrous materials.*—[Sealed 15th March, 1839.]

The patentee says that the fibrous materials, cotton, wool, silk, flax, &c., having been made into the forms of fabrics by various means, such as felting, weaving, plaiting, knitting and lacing, and the same having been rendered waterproof by saturating them with a solution of Indian rubber, he does not claim any of these as forming a part of his invention; but that his improvement consists in placing a series of the threads, yarns, or strands of any of those fibrous materials, parallel, side by side, in contact in one continued plane, and causing them to adhere together by coating their surfaces with solutions of caoutchouc (Indian rubber,) shellac, or any other resinous matters, so as to produce a water-proof fabric.

The manner in which these threads, yarns, or strands of fibrous materials are to be spread out, so as to form a sheet, is not important; but in order to give the best information in his power, he describes one mode which he has found suited to the purpose.

He provides a large cylindrical drum of circumference and length equal to the dimensions of the sheet of fabric to be made; which drum being mounted upon an axle in suitable bearings, is enabled to revolve. A certain number of threads or yarns are then conducted from a series of bobbins or spools severally through the apertures of a reed, and their ends, in the first instance, made fast to the surface of the drum. The reed is affixed to a screw-box or nut, working upon a long horizontal screw-shaft, placed parallel to and in front of the drum. The drum is then put into rotary motion, which, by revolving, draws the threads or yarns from the bobbins or spools through the reed, and winds them round its periphery, in parallel position, side by side.

As the drum revolves, some gearing wheels connected to its axle give rotary motion also to the long screw-shaft, which causes the reed to travel along the screw by a slow progressive movement, and thereby to guide the threads or yarns upon the periphery of the drum in helical curves, until the nut with the reed has arrived at the end of the screw, when the threads or yarns will be found to have completely covered or clothed the entire surface of the cylindrical drum, in a similar way to the spreading of a warp in a warping-mill.

This laying of the fibrous materials in a smooth surface upon or round the periphery of the drum, being effected, a solution of Indian rubber or other suitable resinous material, is then applied and spread over the surface of the yarns or threads so extended upon the drum; and in order that the solution may be laid evenly upon the threads, a scraper formed by a staight-edge is brought near to the surface of the drum, and as the drum revolves, the superfluous adhesive material is scraped off.

The fabric so produced is then allowed to dry upon the drum,—that is, the adhesive material is suffered to become set, or nearly so; when, if the fabric is not sufficiently thick, another layer of the threads or yarns may be wound upon the former in the way and by the machinery above described,

and a further coating of the adhesive material may be put upon it in like manner; and when dry, the sheet must be removed from the surface of the drum, and will be found to be a water-proof fabric fit for use.

The patentee proposes, as a variety or modification of his invention, to cover the cylinder, in the first instance, with a woven fabric of cotton, wool, flax, or other material, and having wound upon this the threads or yarns in helical curves, side by side, as described, to coat the surface with the adhesive material, as before said. and then to place upon this, as an outer surface, a sheet of silk or any other fabric, and by that means to produce a water-proof fabric, having an ornamental or elegant face, for a superior sort of clothing, as for ladies' cloaks, scarfs, and other parts of garments.

Jour. Arts & Science.

Specification of a patent granted to JAMES DAVIS, *Esq., of the county of Middlesex, for Improvements in the Manufacture of Soap.*—[Sealed April 23, 1839.]

In producing the various compositions hereinafter described, I manufacture soap in the same manner, in all respects, as that at present in use, up to the point when the soap is poured or cleansed into frames, or I take soap and remelt it, first, to produce a soap to be used in woollen manufactures and for washing every description of goods in salt or fresh water, and for general purposes at sea or on land, for every 126 lbs. of soap I take 56 lbs. of fuller's-earth slacked or dried, 56 lbs. of dried pipe-clay, and 112 lbs. of calcined soda, all reduced to a powder and sifted as fine as possible; I then pour the 126 lbs. of yellow or mottled soap in a liquid state from the boiler into the powder composed of the above mentioned materials, and mix the soap and the powder well together by stirring and grinding, then pour the compound-soap into frames to cool; great care should be observed in well combining the materials, and the mixing should be performed as quickly as possible before the soap cools.

Secondly, to obviate any possible objection, which might be suggested against the use of a soap or composition, partly prepared from fuller's-earth, for washing white linens, and other purposes, I produce a soap or composition for the washing of white linens, and for those purposes to which the firstly described soap or composition might possibly be considered inapplicable by the several following methods. In producing a soap or composition for the washing of white linens in salt water, or such other general purposes at sea as are hereinbefore referred to, I entirely omit the use of fuller's-earth, and for every 120 lbs. of yellow or mottled soap, I take 112 lbs. of dried pipe-clay, and add 96 lbs. of calcined soda, all reduced to a powder, and sifted as fine as possible, into which the soap is poured, and the mixture is then blended and formed for use, as before described.

Thirdly, in producing a soap or composition for the washing of white linens in fresh water, and for such other general purposes, on shore, as are hereinbefore referred to, I also entirely omit the use of fuller's-earth, and for every 112 lbs. of soap, I take 28 lbs. of dried pipe-clay, and 36 lbs. of calcined soda, and all reduced to a powder, and sifted as fine as possible, into which the soap is poured, and the mixture is then blended and formed for use, as before described.

Fourthly, to produce a soap or composition for the toilet, to be used either in salt or fresh water. For every 112 lbs. of curd soap, I take 28 lbs. of

fuller's-earth, slacked or dried, 20 lbs. of calcined soda, and scented oil, according to fancy, the fuller's-earth and calcined soda being both reduced to a powder, and sifted as fine as possible, into which the soap is poured, and the mixture is blended and formed for use, as before described. In place of employing calcined soda, calcined pearlash may be used in precisely the same manner as that directed for the use of calcined soda; but in about one-half the quantity. I would however remark, that I prefer the use of calcined soda for all classes of soap, where it is to be employed by persons in contact with the skin to which pearlash is irritating.

Having thus described the nature of my invention, and the manner of performing the same, I do hereby declare, that what I claim is the mode of making soap by incorporating therewith calcined soda, fuller's-earth, or pipe-clay, or both fuller's-earth and pipe-clay, as above described. And I also claim the mode of making soap by incorporating therewith calcined pearlash, fuller's-earth, or pipe-clay, or both fuller's-earth and pipe-clay as above described.

Rep. Pat. Inven.

Specification of a patent granted to Moses Poole, *of the county of Middlesex, for Improvements in the Manufacture of Soap, by the Application of Materials not hitherto used for that purpose.*—[Sealed June 4, 1839.]

The invention relates to the application of a product of fish obtained by means of digesting fish as early as possible after they are taken, without other preparation, in a Papin or such like digester. And in order to give the best information in my power, I will proceed to explain more fully the means pursued in order to perform the invention. But I would first remark, that I am aware that it is not new to employ fish or parts of fish in the making of soap, by submitting them with alkali to certain processes, but which having nothing to do with this invention, no description is required in this specification, and I have only mentioned the circumstance in order to disclaim all right and title to the employment of fish or parts thereof, in the making of soap when applied under other circumstances than according to this my specification. The apparatus and process of digesting bone in Papin's or such like digesters being well known, it will not require description here, and as a like process is to be performed on fish, by preference, in the state they are taken, and as soon after as convenient, little description will be required, the invention not relating to the process but to the application of the product in the making of soap. It may be desirable to state, that any description of fish may be used which can be obtained in large quantities, and at a cost which will allow of this application of the product obtained therefrom. And I may state that herrings and sprats are particularly applicable for the purpose. The fish are to be placed in the digester or boiler in the state they are taken, and by means of the digesting process with steam are to be wholly reduced to a jelly, which by preference should be immediately converted into soap either by itself or combined with fatty matters at present employed; but it is better to combine such product with an equal weight of tallow or other suitable fatty material for making soap, the product of fish being gradually incorporated with the tallow or fatty material in the boiler, and such product of fish alone or combined with other fatty matters are to be converted into soap by alkali, or by any of the ordinary means now practised in making soap from tallow or other fatty mat-

ters. The digesting process is performed with steam at 50 to 70lbs. on the square inch, the fish being covered with water at the commencement, and the process takes about five to seven hours.

Having thus described the nature of the invention, I would have it understood that what I claim is the mode of making soap by the application of a product of fish obtained by digesting as above described. Ibid.

Specification of a patent granted to WILLIAM VICKERS, *of the county of York, for an improvement in the Manufacture of Cast Steel.*—[Sealed June 25, 1839.]

To all to whom these presents shall come, &c. &c.—*Now know ye*, that in compliance with the said proviso, I, the said William Vickers, do hereby declare the nature of the said invention, to consist in the manufacture of cast steel at one process, out of borings or turning of wrought iron, (a cheap and refuse material not heretofore used for that purpose,) or out of small wrought iron scaps, such as old horse-shoe nails, broken bits of wire, and the like, by the introduction of oxide of manganese and carbon. And in further compliance with the said proviso, I, the said William Vickers, do hereby describe the manner in which the said invention is to be performed, by the following statement thereof (that is to say):—

In order to make cast steel on the said improved plan, the ordinary furnaces and crucibles, heats and moulds, may be used, (I prefer, however, a slightly increased temperature,) but instead of melting in these crucibles, broken pieces of bar-steel, commonly called blister-steel, as heretofore, from which to make the cast steel ingots, I melt the following ingredients together in the following proportions, that is to say: first, of ordinary wrought iron turnings or boring, or scraps, 100 lbs; second, of black oxide of manganese, two pounds; third, of best ground charcoal, three pounds. Or instead of the ground charcoal, cast-iron turnings, or borings, or other small particles of cast-iron may be used, in which case the following will be the proper proportions, that is to say: first, of ordinary wrought iron borings, or turnings, or scraps, 100 lbs; second, of black oxide of manganese, two pounds three ounces; third, of cast-iron turning, or borings, or other such very small particles of cast-iron, twenty-eight pounds.

Now, whereas, it is evident that the foregoing proportions may be, in both cases, susceptible of some slight variations, dependent on the quality of the ingredients used; and it is only necessary further to observe, that if turnings are used, they should be pounded into small pieces before they are put into the crucible. But I claim as the invention aforesaid, the manufacturing of cast steel at one process from borings of wrought iron, or from turnings of wrought iron, or from wrought iron small scraps melted up with oxide of manganese, and also with carbon or with cast-iron turnings or borings, or other such very small particles of cast-iron, instead of the charcoal as hereinbefore mentioned. And such invention being to the best of my knowledge and belief entirely new, and never before used, within that part of her said Majesty's United Kingdom of Great Britain and Ireland, called England; Her said dominion of Wales, and town of Berwick-upon-Tweed, nor in any of Her said Majesty's colonies and plantations abroad; I do hereby declare this to be my specification of the same; and that I do verily believe this, my said specification, doth comply in all respects fully

and without reserve or disguise with the proviso, in the said hereinbefore in part recited letters patent contained; wherefore I do hereby claim to maintain exclusive right and privilege to the said invention. Ibid.

Specification of a patent granted to Sir William Burnett, *of the county of Middlesex, for his invention of improvements in preserving wood and other vegetable matters from decay.*—[Sealed July 26th, 1838.]

This invention consists in destroying the tendency of certain vegetable substances to decay, by submitting them to the action of chloride of zinc.

In preparing wood, canvas, cordage, sail-cloth, hemp, flax, and other vegetable matter, or articles made thereof, I provide a tank or other vessel of wood, or other suitable material; I then fill it about two-thirds full of chloride of zinc, dissolved in cold water, in the proportion of one pound of chloride of zinc to five gallons of water,—this I allow to remain for ten or twelve hours, when the solution is ready; I then place the material which is to be prepared in the solution, keeping it completely covered by the liquid.

If wood or timber is to be prepared, I allow it to remain in the solution from ten to twenty-one days, according to its size and thickness,—that is to say, if the timber be of the thickness of from eight to thirteen inches and upwards, I leave it immersed in the solution for twenty-one days; if from four to eight inches thick, for fourteen days; and if less than four inches thick, for ten days. When the wood or timber has been so immersed, I take it out and place it in a situation, sheltered from the weather, until it becomes perfectly dry.

In preparing canvas and cloth, I keep them in the solution for forty-eight hours, and then dry them under cover; and in this manner other vegetable materials of thin texture may be prepared.

In the preparation of rope or cordage, above the thickness of two inches, I steep the hemp or yarns, of which the same is to be formed, in the solution for forty-eight hours, and cordage or rope of two inches or less, I steep in the solution for seventy-two hours. In all cases, if tar is to be employed, the yarns forming the cordage should be placed in the solution for forty-eight hours, and allowed to dry before undergoing the tarring process.

In ship-building, and in building or repairing houses, besides preparing the timber to be used therein, as above described, I find it desirable to use a paint made by grinding impure oxide of zinc (lapis calaminaris) with oil or other suitable vehicle. This paint I recommend to be applied, at the time the materials are brought into contact, to the faying parts of all scarfs, and on the joists and faying parts wherever else two pieces of timber are brought into contact, and also on the under-sides of the flats of all magazine platforms, and all other platforms, below the orlops of ships of the line, and lower decks of frigates, and below the upper decks of sloops and smaller vessels.

In houses I recommend the paint, made as before stated, for the inside of skirting and wainscoating, of ground floors, and upon every part of the timber materials below the external surface of ground floors.

And I claim, as my improvements in preserving wood or other vegetable materials from decay, the use of the solution, above described, in the manner herein set forth. Lond Jour. Arts & Sci.

Specification of a patent granted to SAMUEL SANDERSON HALL, *of the city of London, for improvements in preserving certain vegetable substances from decay, being a communication.*—[Sealed 3rd August, 1838.]

The claim set forth by the patentee, is for preserving wood and other vegetable substances from decay, by means of a solution of creosote, or essence of coal tar, dissolved in water. Ibid.

Specification of a patent granted to JOSEPH PONS, *of the county of Surrey, for an improved process of hardening wood and iron, and rendering wood repulsive of vermin and proof against dry-rot.*—[Sealed 22nd June, 1839.]

This improvement consists in the employment of a certain chemical solution in which the wood is to be steeped for a certain time, or the iron is to be dipped when in a heated state.

The chemical solution is described as formed by combining one hundred pounds of sulphate of iron, or of iron filings, with twenty-five pounds of nitric acid,—into which is to be introduced other solutions, viz: twenty-five pounds of alum, fourteen pounds of saltpetre, and five pounds of prussiate of potash. Each of these being separately dissolved in warm water, are to be mixed with the acid solution above described.

A wooden vat or tank is to be employed for holding this chemical solution, which should be kept at a temperature of about 5° Reaumur's thermometer. In this the wood to be hardened should remain immersed for a certain space of time, according to its substance. For pieces of wood from three to five inches in thickness, steeping for three or four days will be sufficient.

Hardening cast-iron, is effected by dipping it in the same chemical solution. The iron is to be heated to a blood-red heat, and then immersed in the liquor for a few minutes.

Wrought iron must be differently treated.—A paste is to be made by mixing five gallons of size with fourteen pounds of saltpetre and five pounds of prussiate of potash. With this paste the iron is to be coated in a cold state, and after having been heated to a blood-red, the iron is to be immersed in the chemical solution for about three minutes.

The patentee says he claims the above described processes for hardening wood and iron; but observes that "beneficial results may be obtained by dispensing with the saltpetre and potash." Ibid.

Specification of a patent granted to JOHN PETRIE, *of Rochdale, in the county of Lancaster, mechanist and engineer, for his invention of certain improvements in steam engines.*—[Sealed 25th July, 1838.]

These improvements consist merely in heating the water before it is introduced into the boiler, by passing eduction steam from the working cylinder into a detached vessel, called a *caloric extractor.* Into this vessel the feed water is conducted by a cock, and the steam allowed to pass in at the same time by another aperture, so as to mix with the water; by which means the patentee proposes to raise its temperature to the boiling point before it is pumped into the boiler.

The claim of invention set out, is placing the caloric extractor between the working cylinder and the condenser of a low pressure engine, and be-

tween the working cylinder and the chimney in a high pressure engine, and regulating the supply of water to the caloric extractor, so that it shall never be introduced into the boiler at a lower temperature than 212° Fahrenheit.

Ibid.

Specification of a patent granted to JAMES WALTON, *of the county of York, for his invention of improvements in machinery for facilitating the operations of raising, dressing, and cropping the pile of woollen and some other fabrics.*—[Sealed 14th January, 1834.]

The subjects of this patent apply to the machine called a gig mill, in which a rotary barrel or barrels, partially covered with teasles, wire cards, or brushes, act against the surface of woollen cloths, for the purpose of drawing out the ends of the wool, called *raising the pile*. The same contrivances are also described as applicable to machines for cropping or shearing the pile.

As the cloth passes under or over the periphery of the gig barrels in an extended length, it is subject to wrinkle toward the middle of the barrel, and requires to be kept extended by the attendants continually pulling the lists outward. This the patentee proposes to remedy by changing the positions of the drawing and conducting rollers, so that the cloth may pass over or under the gig barrels, not exactly in the direction of a right angle to the axles of the barrel, but in a diagonal or oblique direction. This he effects by mounting the drawing and conducting rollers upon a movable frame, independent of that which supports the gig barrels, and giving to this frame a vibratory motion, so that the axles of the several rollers which conduct the cloth through, preserving their parallelism to each other, will be brought into such situations as will form angles of considerable obliquity to the axles of the gig barrels. By these means, as the frame and rollers vibrate, the cloth will be drawn first toward one side of the gig barrel and then toward the other side, and be thereby prevented from wrinkling in the middle.

The same contrivance will apply to such shearing machines as work with rotary cutters, and will assist in effecting a very desirable object, viz., cutting or cropping the pile in diagonal directions.

The second feature of the invention, is applying cushions with India rubber surfaces to parts of the periphery of the gig barrel, for the purpose of smoothing and polishing the face of the cloth.*—This is not new.

The third improvement is the introduction of cushions, filled with water or air, as elastic beds, for pressing the cloth against the gig barrels, or against the cutters in the shearing frame.—This has also been done before, many years ago.

The fourth feature of invention, is the employment of double-threaded screws,—that is, screw shafts having a right-handed thread at one end, and a left-handed thread at the other, so that on being turned they may cause the distances of the rails of a stretching frame, to expand or contract.—This is likewise a very common and well known contrivance for the same purpose.

Ibid.

* India rubber was applied exactly in the same way by Mr. G. D. Harris.—See his Patent of Jan. 15th, 1828, Vol. VI. p. 258, of Second Series of the London Journal of Arts and Sciences.

On the Caoutchouc Manufacture. By Andrew Ure, *M. D., F. R. S., &c. &c.*

This department of operative industry has, within a few years, acquired an importance equal to some of the older arts, and promises, ere long, to rival even the ancient textile fabrics in the variety of its designs and applications. The manufacture of caoutchouc has, at present, three principal branches—1. The condensation of the crude lumps or shreds of caoutchouc, as imported from South America, India, &c., into compact homogeneous blocks, and the cutting of these blocks into cakes or sheets for the stationer, surgeon, shoemaker, &c. 2. The filature of either the Indian rubber bottles, or the artificial sheet caoutchouc, into tapes and threads of any requisite length and fineness, which, being clothed with silk, cotton, linen, or woollen yarns, form the basis of elastic tissues of every kind. 3. The conversion of the refuse cuttings and coarser qualities of caoutchouc into a viscid varnish, which, being applied between two surfaces of cloth, constitutes the well-known double fabrics, impervious to water and air.

I. The caoutchouc, as imported in skinny shreds, fibrous balls, twisted concretions, cheese-like cakes, and irregular masses, is, more or less, impure, and sometimes fraudulently interstratified with earthy matter. It is cleansed by being cut into small pieces, and washed in warm water. It is now dried on iron trays, heated with steam, while being carefully stirred about to separate any remaining dirt, and is then passed through, between a pair of iron rolls, under a stream of water, whereby it gets a second washing, and becomes, at the same time, equalised, by the separate pieces being blended together. The shreds and cuttings thus laminated, if still foul or heterogeneous, are thrown back into a kind of hopper over the rolls, set one-sixteenth of an inch apart, and passed several times through between them. The above method of preparation is that practised by Messrs. Keene & Co., of Lambeth, in their excellent manufactory, under a patent granted in October, 1836, to Christopher Nickels, a partner in the firm.

In the great establishment of the Joint Stock Caoutchouc Company, at Tottenham, under the direction of Mr. Sievier, a gentleman distinguished no less by his genius and taste as a sculptor, than by his constructive talents, the preparatory rinsing and lamination are superseded by a process of washing practised in Mr. Nickels' second operation, commonly called the *grinding*, or, as it should more properly be styled, the *kneading*. The mill employed for agglutinating or incorporating the separate fragments and shreds of caoutchouc into a homogeneous elastic ball, is a cylindrical box or drum of cast iron, eight or nine inches in diameter, set on edge, and traversed in the line of its horizontal axis (also eight or nine inches long) by a shaft of wrought iron, furnished with three rows of projecting bars, or kneading arms, placed at angles of 120 deg. to each other. These act by rotation against five chisel-shaped teeth, which stand obliquely up from the front part of the bottom of the drum. The drum itself consists of two semi-cylinders; the under of which is made fast to a strong iron framing, and the upper is hinged to the under one behind, but bolted to it before, so as to form a cover or lid, which may be opened or laid back at pleasure, in order to examine the caoutchouc from time to time, and take it out when fully kneaded. In the centre of the lid a funnel is made fast, by which the cuttings and shreds of the Indian rubber are introduced, and a stream of water is made to trickle

in, for washing away the foul matter often imbedded in it. The power required to turn the axis of one of these mills, as the drums or boxes are called, may be judged of from the fact, that if it be only two inches in diameter, it is readily twisted asunder, and requires to be three inches to withstand every strain produced by the fixed teeth holding the caoutchouc against the revolving arms. Five pounds constitute a charge of the material.

One of the most remarkable phenomena of the kneading operation, is the prodigious heat disengaged in the alternate condensation and expansion of the caoutchouc. Though the water be cold as it trickles in, it soon becomes boiling hot, and emits copious vapours. When no water is admitted, the temperature rises much higher, so that the elastic lump, though a bad conductor of heat, cannot be safely touched with the hand. As we shall presently find that caoutchouc suffers no considerable or permanent diminution of its volume by the greatest pressure which can be applied, we must ascribe the heat evolved in the kneading process to the violent intestine movements excited throughout all the particles of the elastic mass.

During the steaming, much muddy water runs off through apertures in the bottom of the drum. In the course of half an hour's trituration, the various pieces become agglutinated into a soft, elastic, ovoid ball, of a reddish brown colour. This ball is now transferred into another similar iron drum, where it is exposed to the pricking and kneading action of three sets of chisel points, five in each set, that project from the revolving shaft at angles of 120 deg. to each other, and which encounter the resistance occasioned by five stationary chisel teeth, standing obliquely upwards from the bottom of the drum. Here the caoutchouc is kneaded dry along with a little quicklime. It soon gets very hot, discharges in steam through the punctures, the water and air which it had imbibed in the preceding washing operation, becomes, in consequence, more compact, and, in about an hour, assumes the dark brown colour of stationers' rubber. During all this time frequent explosions take place, from the expansion and sudden extrication of the imprisoned air and steam.

From the second set of drums the ball is transferred into a third set, whose revolving shaft, being furnished with both flat pressing bars, parallel, and sharp chisels, perpendicular to it, exercises the twofold operation of pricking and kneading the mass, so as to condense the caoutchouc into a homogeneous solid. Seven of these finished balls, weighing, as above stated, five pounds each, are then introduced into a much larger iron drum of simi lar construction, but of much greater strength, whose shaft is studded all round with a formidable array of blunt chisels. Here the separate balls become perfectly incorporated into one mass, free from honeycomb-cells or pores, and therefore fit for being squeezed into a rectangular or cylindrical form in a suitable cast iron mould, by the action of a screw press. When condensed to the utmost in this box, the lid is secured in its place by screw bolts, and the mould is set aside for several days. It is a curious fact that Mr. Sievier has tried to give this moulding force, by the hydraulic press, without effect, as the cake of caoutchouc, after being so condensed, resiles much more considerably than after the compressing action of the screw. The cake form generally preferred for the recomposed, ground, or milled caoutchouc, is a rectangular mass, about 18 inches long, 9 inches broad, and 5 inches thich.

This is sliced into cakes for the stationer, and into sheets for making tapes and threads of caoutchouc, by an ingenious self-acting machine, in which a straight steel blade, with its edge slanting downwards, is made to vibrate

most rapidly to and fro in a horizontal plane; while the cake of caoutchouc, clamped or embraced at each side between two strong iron bars, is slowly advanced against the blade by screw work, like that of the slide rest of a lathe. In cutting caoutchouc by knives of every form, it is essential that either the blade or the incision be constantly moistened with water; for otherwise the tool would immediately stick fast. Since the above straight vibrating knife slants obliquely downwards, the sheet which it cuts off spontaneously turns up over the blade in proportion as it is detached from the bottom mass of the cake. The thicker slices are afterwards cut by hand, with a wetted knife, into small parallelopipeds, for the stationer, the sections being guided rectangularly by saw lines in a wooden frame. The wholesale price of these is now reduced to 2s. per pound. Slices may be cut off to almost any desired degree of thinness, by means of an adjusting screw mechanism, that acts against a board which supports the bottom of the cake, and raises it by any aliquot part of an inch, the cutting blade being caused to vibrate always in the same horizontal plane. These thin slices constitute what is called sheet caoutchouc, and they serve perfectly for making tubes for pneumatic apparatus, and sheaths of every kind; since, if their two edges be cut obliquely with clean scissors, they may be made to coalesce, by great pressure, so intimately, that the line of junction cannot be discovered either by the eye, or by inflation of a bag or tube thus formed.

The mode of recomposing the cuttings, shreds, and coarse lumps of caoutchouc into a homogeneous elastic cake, specified by Mr. Nickels, for his patent, sealed October 24, 1836, is not essentially different from that above described. The cylinders of his mill are more capacious, are open at the sides like a cage, and do not require the washing apparatus, as the caoutchouc has been cleansed by previous lamination and rinsing. He completes the kneading operation, in this open cylinder, within the space of about two hours, and afterwards squeezes the large ball so formed into the cheese form, in a mould subjected to the action of a hydraulic press. As he succeeds perfectly in making compact cakes in this way, his caoutchouc must differ somewhat in its physical constitution from that recomposed by Mr. Sievier's process. He uses a press of the power of 70 tons; such pressure, however, must not be applied suddenly, but progressively, at intervals of two or three minutes between each stroke; and when the pressing is complete, he suffers the caoutchouc to remain under pressure till it is cold, when he thrusts it out of the mould entirely, or, placing his mould in the slide-rest mechanism, he gradually raises the caoutchouc out of it, while the vibrating knife cuts it into slices in the manner already described. The elegant machine by which these sheets are now so easily and accurately sliced, was, I believe, originally contrived and constructed by Mr. Beale, engineer, Church-lane, Whitechapel.

II. *Filature of Caoutchouc for making Elastic Fabrics.*—Messrs. Rattier and Guibal mounted in their factory at St. Denys, so long ago as the year 1826 or 1827, a machine for cutting a disc of caoutchouc into a continuous fillet spirally, from its circumference towards its centre. This flat disc was made by pressing the bottom part of a bottle of Indian rubber in an iron mould. I have described this machine under the article Elastic Bands, in my Dictionary of Arts, &c. A machine on the same principle was made the subject of a patent by Mr. Joshua Proctor Westhead, of Manchester, in Feb. 16, 1836; and, being constructed with the well-known precision of Manchester workmanship, it has been found to act perfectly well in cutting

a disc of caoutchouc, from the circumference towards the centre spirally, into one continuous length of tape. For the service of this machine, the bottom of a bottle of Indian rubber of good quality being selected, is cut off and flattened by heat and pressure into a nearly round cake of uniform thickness. This cake is made fast at its centre by a screw nut and washer to the end of a horizontal shaft, which may be made to revolve with any desired velocity by means of appropriate pulleys and bands, at the same time that the edge of the disc of caoutchouc is acted on by a circular knife of cast steel, made to revolve 3000 times per minute, in a plane at right angles to that of the disc, and to advance upon its axis progressively, so as to pare off a continuous uniform tape or fillet from the circumference of the cake. During this cutting operation, the knife and caoutchouc are kept constantly moist with a slender stream of water. A succession of threads of any desired fineness are afterwards cut out of this fillet, by drawing it in a moist state through a guide slit, against the sharp edge of a revolving steel disc. This operation is dexterously performed by the hands of young girls. MM. Rattier and Guibal employed, at the abovementioned period, a mechanism consisting of a series of circular steel knives, fixed parallel to each other at minute distances, regulated by interposed washers upon a revolving shaft; which series of knives acted against another similar series, placed upon a parallel adjoining shaft, with the effect of cutting the tape throughout its length into eight or more threads at once. An improved modification of that apparatus is described and figured in the specification of Mr. Nickel's patent of October, 1836. He employes it for cutting into threads the tapes made from the recomposed caoutchouc.

The body of the bottle of Indian rubber, and in general any hollow cylinder of caoutchouc, is cut into tapes by being first forced upon a mandril of soft wood of such dimensions as to keep it equally distended. This mandril is then secured to the shaft of a lathe, which has one end formed into a fine-threaded screw, that works in a fixed nut, so as to traverse from right to left by its rotation. A circular disc of steel, kept moist, revolves upon a shaft parallel to the preceding, at such a distance from it as to cut through the caoutchouc, so that, by the traverse movement of the mandril shaft, the hollow cylinder is cut spirally into the continuous fillet of a breadth equal to the thickness of the side of the cylinder. Mr. Nickels has described two methods of forming hollow cylinders of recomposed caoutchouc for the purpose of being cut into fillets by such a machine.

It is probable that the threads formed from the best Indian rubber bottles, as imported from Para, are considerably stronger than those made from recomposed caoutchouc, and therefore much better adapted for making Mr. Sievier's beautiful patent elastic cordage. When, however, the kneading operation has been skilfully performed, I find that the threads of the *ground* caoutchouc, as it is incorrectly called by the workmen, answers well for every ordinary purpose of elastic fabrics, and are of course, greatly more economical, from the much lower price of the raw material.

Threads of caoutchouc are readily pieced by paring the broken ends obliquely with scissors, and then pressing them together with clean fingers, taking care to admit no grease or moisture within the junction line. These threads must be deprived of their elasticity before they can be made subservient to any torsile or textile manufacture. Each thread is *inelasticated* individually in the act of reeling, by the tenter boy or girl pressing it between his moist thumb and finger, so as to stretch it to at least eight times its natural length, while it is drawn rapidly through between them by the

rotation of the power-driven reel. This extension is accompanied with condensation of the caoutchouc, as shown in my former paper (see this Journal for last month,) and with very considerable disengagement of heat, as pointed out in Nicholson's Journal, upwards of 30 years ago, by Mr. Gough, the blind philosopher of Kendal. I attempted to stretch the thread, in the act of reeling, but found the sensation of heat too painful for my unseasoned fingers. The reels, after being completely filled with the thread, are laid aside for some days, more or fewer, according to the quality of the caoutchouc, the recomposed requiring a longer period than the bottle material. When thus rendered inelastic, it is wound off upon bobbins of various sizes, adapted to various sizes of brading, or other machines, where it is to be clothed with cotton or other yarn.

The thread of the Joint Stock Caoutchouc Company is numbered from 1 to 8. No. 1 is the finest, and has about 5000 yards in a pound weight; No. 4 has 2000 in a pound weight; and No. 8, 700, being a very powerful thread. The finest is used for the finer elastic tissues, as for ladies' silver and gold elastic bracelets and bands. The ropes made by Mr. Sievier with the strongest of the above threads, clothed with hemp, and worked in his gigantic braiding machine, possess, after they are re-elasticated by heat, an extraordinary strength and elasticity, and, from the nearly rectilinear direction of all the strands, can stand, it is said, double the strain of the best patent cordage of like diameter.

In treating of the manufacture of elastic fabrics, I have great pleasure in adverting to the ribbon looms at Holloway, which display to great advantage the mechanical genius of the patentee, Mr. Sievier. Their productive powers may be inferred from the following statement:—5000 yards of one inch braces are woven weekly in one 18 ribbon loom, whereby the female operative, who has nothing to do but to watch its automatic movements, earns 10s. a week; 3000 yards of two inch braces are woven upon a similar loom in the same time. But one of Mr. Sievier's most curious patent inventions, is that of producing, by the shrinking of the caoutchouc threads in the foundation or warp of the stuff, the appearance of raised figures, closely resembling coach lace, in the weft. Thus, by a simple physical operation, there is produced, at an expense of one penny, an effect which could not be effected by mechanical means for less than one shilling.

III. *Of the Water-proof Double Fabrics.*—The parings, the waste of the kneading operations above described, and the coarsest qualities of imported caoutchouc, such as the inelastic lumps from Para, are worked up into varnish, wherewith two surfaces of cloth are cemented, so as to form a compound fabric, impervious to air and water. The caoutchouc is dissolved either in petroleum (coal tar) naphtha, or oil of turpentine, by being triturated with either of the solvents in a close cast iron pot, with a stirring apparatus, moved by mechanical power. The heat generated during the attrition of the caoutchouc, is sufficient to favour the solution, without the application of fuel in any way. These triturating pots have been called pug mills by the workmen, because they are furnished with obliquely pressing and revolving arms, but in other respects they differ in construction. They are four feet in diameter and depth, receive 15 cwt. at a time, have a vertical revolving shaft of wrought iron four inches in diameter, and make one turn in a second. Three days are required to complete the solution of one charge of the varnish materials. The proportion of the solvent oils varies with the object in view, being always much less in weight than the caoutchouc.

When the varnish is to be applied to very nice purposes, as bookbinding,

&c., it must be rubbed into a homogeneous smooth paste, by putting it in a hopper, and letting it fall between a couple of parallel iron rolls, set almost in contact.

The wooden framework of the gallery in which the waterproof cloth is manufactured, should be at least 50 yards long, to give ample room for extending, airing, and drying the pieces; it should be two yards wide, and not less than five high. It is formed of upright standards of wood, bound with three or four horizontal rails at the sides and the ends. At the end of the galley, where the varnish is applied, the web which is to be smeared must be wound upon a beam, resembling in size and situation the cloth beam of the weaver's loom. The piece is thence drawn up and stretched in a horizontal direction over a bar, like the breast beam of a loom, whence it is extended in a somewhat slanting direction downwards, and passed over the edge of a horizontal bar. Above this bar, and parallel to it, a steel-armed edge of wood is adjusted, so closely as to leave but a narrow slit for the passage of the varnish and the cloth. This horizontal slit may be widened or narrowed at pleasure by thumb screws, which lower or raise the movable upper board. The caoutchouc paste being plastered thickly with a long spatula of wood upon the down-sloped part of the web, which lies between the breast beam and the above described slit; the cloth is then drawn through the slit by means of cords in a horizontal direction along the lowest rails of the galley, whereby it gets uniformly besmeared. As soon as the whole web, consisting of about 40 yards, is thus coated with the viscid varnish, it is extended horizontally upon rollers, in the upper part of the gallery, and left for a day or two to dry. A second and third coat are then applied in succession. Two such webs, or pieces, are next cemented face to face, by passing them, at the instant of their being brought into contact, through between a pair of wooden rollers, care being taken by the operator to prevent the formation of any creases, or twisting of the twofold web. The under of the two pieces being intended for the lining, should be a couple of inches broader than the upper one, to ensure the uniform covering of the latter, which is destined to form the outside of the garment. The double cloth is finally suspended in a well ventilated stove room, till it becomes dry, and nearly free from smell. The parings cut from the broader edges of the under piece, are reserved for cementing the seams of cloaks and other articles of dress. The tape-like shreds of the double cloth are in great request among gardeners, for nailing up the twigs of wall shrubs.

Mr. Walton, of Sowerby-bridge, has recently substituted sheet Indian rubber for leather, in the construction of fillet cards for the cotton and tow manufactures. The superior elasticity of this article is said to prove advantageous in several respects. Jour. Arts & Science.

On the mode of Producing Fac-simile copies of Medals, &c., by the agency of Voltaic Electricity.

Sir,—You request a condensed account of my voltaic process of working in copper. I shall endeavour to give you one, premising, I shall divest it as much as possible of electro-chemical detail, that it may be rendered quite intelligible to those unacquainted with that science.

It has been long known that one metal will precipitate another from its solution. As one instance, if we take a solution of sulphate of copper, the blue vitriol of commerce, and dip the blade of a penknife in it, in a few seconds it becomes coated with pure metallic copper. We have here an

instance of simple electro-chemical action, and I may say, the type of all the experiments I have lately published on the subject. Subsequently, it has been found that copper itself possessed this quality, by acting on *its own* solutions, and to a much greater extent than in the first instance, but under a somewhat different condition.

If we take a clean copper wire, and dip it into a solution of the sulphate of copper, on taking it out, we find no preceptible difference is made on its surface. If we now take the copper wire, or slip of that metal, and solder to one of its ends a piece of zinc, and bend the two metals so combined into the shape of the letter U, and again place the copper end in the cupreous solution, and the zinc end in a very weak solution of salt and water,—if allowed to remain some time, it will be found the copper end has received a thin coating of solid copper. In this instance, as in most others connected with continued galvanic arrangement, it is a *sine qua non*, that the two fluids must *not* be allowed to intermingle, yet must be *in* connection with each other.

To effect this, various expedients have been resorted to, with more or less success; but to give a simple illustration of how this may be effected, in order to attain the result mentioned above, take a piece of *stout* brown paper, and bend it into the form of a piece of tube about three inches long, and perhaps an inch in diameter. This may be conveniently done, by bending the paper round a phial to make it assume the desired form; let the edges of the paper overlap, and fasten them together with a bit of sealing wax. A paper tube is thus obtained, open at both ends, but one end must be closed; this may be done simply, by cutting a piece of card into the shape of the bottom end, but a little larger, and fastening it on with sealing wax, just as we would take an impression of a seal, by covering the disc of card with the wax, and while soft dip the end of the paper tube into it; when set, we shall thus obtain a vessel capable, to a certain extent, of containing a fluid, yet, from its porous texture, this fluid would be in connection with any other fluid that might surround it on the other side.

Having obtained such a tube, we three parts fill it with salt and water, or better still, glauber salt and water, which is a sulphate of soda. We then take a common drinking tumbler, containing a quantity of sulphate of copper in solution, and take the paper tube containing the saline solution, and immerse it in the tumbler, taking care that both fluids shall attain the same level. If we now take the bent slip of copper and zinc, and place the copper end of it in the cupreous solution, and the zinc end in the saline solution, contained in the paper tube, and let this remain at rest for a few hours (if in a warm situation so much the better) it will be found on removing the combined pieces of metal, that the copper end has obtained a solid covering of pure copper, I have here described an elementary voltaic battery,—and the most extensive one ever constructed, is only a combination of such simple arrangements connected together by copper wires.

In this arrangement the inside of the paper tube, containing the saline solution, is termed the positive cell,—the outside one—the tumbler containing the cupreous solution,—is termed the negative cell. The zinc end of the combined metals, is termed the positive electrode,—the copper end, the negative electrode. With a modification of this very simple apparatus, all the experiments of this process may be readily performed. I have judged the above explanation necessary, as many persons have imagined the apparatus when constructed, was in some way or other connected to a galvanic battery.

By performing the above experiment, we acquire a clear idea of voltaic arrangement, while the eye becomes acquainted with the phenomena produced.

Were I required to produce an exact fac-simile of a medal in copper, I should proceed as follows:—Suppose it were equal in size to half-a-crown, —I should procure a piece of glass tube, (a short gas glass of the largest diameter does best) and then take a piece of flat glass and oil its surface slightly,—this done, I place one end of the tube on the oiled glass, and pour into it some fluid plaster of paris, to the depth of half or five-eights of an inch; when this sets, the oiled glass will easily slip off, and a porous bottom will thus be given to the tube, which in all cases should be of equal or superior diameter to the medal required to be copied. This, and a common size drinking tumbler, comprehends nearly all the apparatus required.

I should now procure two pieces of pretty thick sheet lead, and with a plane, smooth one of the surfaces of each piece, in the manner wood is planed. I then take the medal to be copied, and place it between the bright surfaces of the pieces of lead, and place the whole under a press. Should the medal not be very large, a copying press will be found sufficient, but when larger, a more powerful one is requisite. In either case the object to be acted on must be under the centre of pressure.

When removed from the press, a most exact mould of each side of the medal will thus be obtained. I now take a piece of copper wire, varying in length according to the size of the apparatus,—in the present instance, from 12 to 16 inches may be used. To one of its ends, I solder a piece of zinc, rounded, and sufficiently large to go into the gas glass. To the other end I solder* one of the leaden moulds. I have now what is termed a "galvanic pair," the leaden mould constituting the negative electrode, and the zinc the positive one.

The wire is now bent in such a form, that the lead and the zinc will be opposed to each other,—the opposed surfaces being distant about 1½ inches. To effect this, bend the wire into a right angle, at its junction with the lead, and place the lead in a horizontal position, at the bottom of the tumbler,—the impressed side being uppermost. The gas glass, with its plaster bottom, must now be placed exactly over the lead mould.† The wire must again be bent in the shape of the letter u, in order that the zinc end may go into the gas glass, and *touch*, or nearly so, its plaster bottom. This like the lead, must lay horizontally, on the bottom of the interior cell. To conveniently effect this, the end of the wire should be soldered to the centre of the zinc disc.

These arrangements being neatly effected, I now pour a hot saturated solution of sulphate of copper into the tumbler, being in connection with the lead.—A few undissolved crystals may be added with advantage.—I next pour a hot solution of glauber salt into the gas glass, in connection with the zinc, taking care it does not exceed the level of the fluid in the outside cell. This latter solution must not be saturated, but only a few crystals of the salt put in the water. This may now be allowed to remain for a day or two, until the blue colour of the cupreous solution is assuming a pale green; then add a few crystals of the salt of copper.—Should a very thick deposition of

* The wire should be soldered to the blank side of the lead.

† In order that the gas glass may not *rest* on the plate to be deposited on, I suspend it by a wooden collar, which rests on the outside vessel, and keeps the bottom of the inside one, at a quarter of an inch distant from the plate.

copper be required, it is well to renew the solutions entirely, as the acid that is set free, materially interferes with the success of the process.

This process may be quickened in a very great degree, by the application of heat, and the metal so deposited, is of a much superior character to that deposited under a common temperature. The apparatus I have described, may be kept at a temperature of from 120 to 160°, by being placed at the side of a fire, and a deposition got in a very few hours.

When it is judged the requisite thickness is deposited, I proceed to get the copper so deposited, off the mould, as follows:—Previous to immersing the lead into the solution, I generally varnish the back and edges of the mould, to prevent deposition on any other portion of its surface than that opposed to the zinc.

On removing it from the apparatus, I file the edges of the copper until they are flush or parallel with the lead. I then heat the copper side by holding it over the fire, and suddenly plunge it in cold water. On examination it will be found some portion is loosened from the lead, when, by inserting the edge of a knife, the plate of copper will come readily off, bearing a *most exact* impress of the original.

I have thus far described how to proceed, in the process of taking a single medal; but it will at once be perceived, that the same instructions apply to a sheet containing an indefinite number, by only enlarging the apparatus. By exactly the same process here described, I have succeeded in obtaining exact copies of engraved wood blocks and copper plates. I have also succeeded in stereotyping in copper, some elaborate ornamental printing, equal in area to a large octavo page.

I have used lead for most of my latter experiments, instead of copper,—as that metal precipitates copper, when in connection with zinc, and it is much easier got off the mould, in consequence of the different degrees of expansibility possessed by the two metals, on the application of heat. The time occupied by the whole process, is also materially abridged. I have not yet had an opportunity of trying the "fusible metal," that melts at a temperature of 212° Fahr. It must also be borne in mind, that as far as our knowledge extends, it is an electro-chemical law, that a *metallic* surface must be present, before we are able to precipitate a metal from its solution.

Want of space compels me to omit several minutiæ, that my experience has suggested, but enough has been said to illustrate the principle, and I may add, it is susceptible of infinite variation.

I have every reason to believe it might be found advantageous to type founders, for the matrix from which they cast type, as copper precipitates very readily, on a surface of type metal.

In conclusion, I may add,—I have no personal intention of turning this process to pecuniary advantage,—should it be capable of being so applied, but should at all times feel happy in communicating my experience of the matter to those desirous of applying it in the arts.

My own expectations have been fully realized, as it has been a means of illustrating a hitherto unsolved geological problem, in connection with some peculiar views I hold on the subject. THOMAS SPENCER.

Liverpool, Dec. 14th.

Ibid.

On the Nature of Yeast and Fermentation. *By* DR. URE.

Yeast, according to my observations, when viewed in a good achromatic microscope, consists altogether of translucent spherical and spheroidal par-

ticles, each about the 6000th part of an inch in diameter. When the beer in which they float is washed away with a little water, they are seen to be colourless; their yellowish tint, when they are examined directly from the fermenting square or round of a porter brewery, being due to the infusion of the brown malt. The yeast of a square newly set seems to consist of particles smaller than those of older yeast, but the difference of size is not considerable. The researches of Schulze, Cagniard de la Tour, and Schwann, appear to show that the vinous fermentation, and the putrefaction of animal matters—processes which have been hitherto considered as belonging entirely to the domain of chemical affinity—are essentially the results of an organic development of living beings. This position seems to be established by the following experiments:—1. A matrass or flask containing a few bits of flesh being filled up to one-third of its capacity with water, was closed with a cork, into which two slender glass tubes were cemented air-tight. Both of these tubes were passed externally through a metallic bath, kept constantly melted, at a temperature approaching to that of boiling mercury. The end of one of the tubes, on emerging from the bath, was placed in communication with a gasometer. The contents of the matrass were now made to boil briskly, so that the air contained in it and the glass tubes was expelled. The matrass being then allowed to cool, a current of atmospherical air was made constantly to pass through it from the gasometer, while the metallic bath was kept constantly hot enough to decompose the living particles in the air. In these experiments, which were many times repeated, no infusoria or fungi appeared, no putrefaction took place, the flesh underwent no change, and the liquor remained as clear as it was immediately after being boiled. As it was found very troublesome to maintain the metallic bath at the melting pitch, the following modification of the apparatus was adopted in the subsequent researches. A flask of three ounces capacity, being one-fourth filled with water and flesh, was closed with a tight cork, secured in its place by wire. Two glass tubes were passed through the cork; the one of them was bent down, and dipped at its end into a small capsule containing quicksilver, covered with a layer of oil; the other was bent on leaving the cork, first into a horizontal direction, and downwards for an inch and a half, afterwards into a pair of spiral turns, then upwards, lastly horizontal, whence it was drawn out to a point. The pores of the cork having been filled with caoutchouc varnish, the contents of the flask were boiled till steam issued copiously through both of the glass tubes, and the quicksilver and oil became as hot as boiling water. In order that no living particles could be generated in the water condensed beneath the oil, a few fragments of corrosive sublimate were laid upon the quicksilver. During the boiling, the flame of a spirit lamp was drawn up over the spiral part of the second glass tube, by means of a glass chimney placed over it, so as to soften the glass, while the further part of the tube was heated by another spirit lamp, to prevent its getting cracked by the condensation of the steam. After the ebullition had been kept up a quarter of an hour, the flask was allowed to cool and get filled with air, through the hot spiral of the second tube. When the contents were quite cold, the end of this tube was hermetically sealed, the part of it between the point and the spiral was heated strongly with the flames, and the lamps were then withdrawn. The matrass contained now nothing but boiled flesh and gently ignited air. The air was renewed occasionally through the second tube, its spiral part being first strongly heated, its point then broken off, and connected with a gasometer, which caused the air to pass onwards slowly, and escape at the end of the first

tube immersed in the quicksilver. The end of the second tube was again hermetically closed, while the part interjacent between it and the spiral was exposed to the spirit flame. By means of these precautions, decoctions of flesh were preserved, during a period of six weeks, in a temperature of from 14° to 20° R. (63½° to 77° F.), without any appearance of putrefaction, infusoria, or mouldiness: on opening the vessel, however, the contents fermented in a few days, as if they had been boiled in the ordinary manner. In conducting such researches, the greatest pains must be taken to render the cork and junctions of the glass tubes perfectly air-tight. The following more convenient modification of the experiment, but one equally successful and demonstrative, was arranged by F. Schulze. The glass tubes connected with the flask, were furnished each with a bulb at a little distance from the cork; into one of which globes caustic alkaline lye being put and into the other strong sulphuric acid, air was slowly sucked through the extremity of the one tube, while it entered at the other, so as to renew the atmosphere over the decoction of flesh in the flask. In another set of experiments, four flasks being filled with a solution of cane-sugar, containing some beer yeast, were corked, and plunged in boiling water till they acquired its temperature. They were then taken out, inverted in a mercurial bath, uncorked, and allowed to cool in that position. From one-third to one-fourth of their volume of atmospherical air was now introduced into each of the flasks; into two of them, through slender glass tubes kept red hot at a certain point, into the other two through glass tubes not heated. By analysis it was found that the air thus heated contained only 19.4 per cent. of oxygen, instead of 20.8; but to compensate for this deficiency, a little more air was admitted into the two flasks connected with the heated tubes, than into the two others. The flasks were now corked and placed in an inverted position, in a temperature of from 10° to 14° R. (54⅛° to 63½° F.) After a period of from four to six weeks, it was found that fermentation had taken place in both of the flasks which contained the non-ignited air—for, in loosening the corks, some of the contents were projected with force—but in the other two flasks, there was no appearance of fermentation, either then or in double the time. As the extract of nux vomica is known to be a poison to *infusoria* (animalcules,) but not to vegetating mould, while arsenic is a poison to both, by these tests it was proved that the living particles instrumental to fermentation belonged to the order of plants of the Confervoid family. Beer yeast, according to Schwann, consists entirely of microscopic fungi, in the shape of small oval grains of yellowish white colour, arranged in rows oblique to each other. Fresh grape must contain none of them; but, after being exposed to the air at 20° R., for thirty-six hours, similar grains become visible in the microscope, and may be observed to grow larger in the course of an hour, or even in half that time. A few hours after these plants are first perceived, gas begins to be disengaged. They multiply greatly in the course of fermentation, and at its conclusion subside to the bottom of the beer in the shape of a yellow white powder.

Athenæum.

On a new Method of distinguishing Arsenic from Antimony, in cases of suspected poisoning by the former substance. *By* Mr. J. Marsh.

In testing for arsenic in cases of poisoning by that substance, it has always been desirable to render the process as simple as possible, and thereby divest the mind of any ambiguity on the subject. It was with this view that

I submitted to the Society of Arts, &c. in the year 1836, my process by hydrogen, a process that I then fondly hoped would have removed all difficulties, but a communication from my friend Mr. Lewis Thompson, and which was inserted in the L. and E. Philosophical Magazine, vol. x. p. 353, has rendered the process in some measure more difficult than was at first supposed, by the discovery of that gentleman, of a compound in which antimony combines with hydrogen to form a gas (antimoniuretted hydrogen). This gas gives off by the process employed, metallic crusts, which much resemble, to the inexperienced eye, the metallic substance obtained from arsenical solutions by the same arrangements. It becomes necessary therefore to find a means of distinguishing these metallic crusts from each other. Many processes which are well known to the experienced chemist may be employed for this purpose; but the misfortune is that all these arrangements suppose a previous chemical acquaintance with the subject; for instance, a good process for this purpose is given by Liebig and Mohr in their valuable Journal (Lieb., *Ann.*, xxiii. 217.) and also a modification of the same, by Berzelius, may be seen copied in the Lancet, vol. i. 1838, p. 819, but these are all liable to the above objection, viz. want of simplicity.

I am happy in being able to lay before your readers a very simple distinguishing test for these bodies, and which I have employed in all cases of doubt with perfect success. The means that I use is simply as follows: After the common arrangements have been made for testing for antimony or arsenic, the piece of glass or porcelain on which the metallic crusts are generally received, is to have a single drop of distilled water placed on it; the glass or porcelain is then to be inverted, so that the drop of water is suspended undermost. The gas as it issues from the jet is to be inflamed in the usual manner, but the piece of glass, &c., with its drop of water, is to be held about an inch above the jet, or just above the apex of the cone of flame: the arsenic by this arrangement is oxidized at the same time that hydrogen is undergoing combustion, and coming in contact with the drop of water held above, forms with it a strong or weak solution of arsenical acid, according to the quantity of arsenic present, should that substance have been in the mixture submitted to examination. A very minute drop of Hume's test (the ammoniacal nitrate of silver) being now dropped on the solution so obtained, if arsenic be present, the well-known characteristic lemon yellow colour produced by this test when used for testing for that substance is immediately produced, namely, the insoluble arsenite of oxide of silver. Antimony under these circumstances, from being insoluble, produces no change. I have found it useful, when much arsenic has been present in the matter submitted to examination, to use a clean glass tube, six inches long, and about half an inch in diameter. I slightly moisten the interior of the tube with distilled water, not allowing the hands or fingers to come in contact with the water: the tube thus prepared is to be held vertically over the apex of the jet of burning gas. By these means a strong solution of the substance is obtained, and which may be tested with perfect ease by Hume's test, or any other of the usual tests employed for arsenic, &c.

I hope that the foregoing process will be found to possess all the delicacy and precision necessary for distinguishing these two bodies from each other, and that it will be the means of removing every doubt from the minds of the experimentalist in future.

Royal Arsenal, Woolwich, June 21, 1839. J. M.

On the separation of Lime from Magnesia, and on the Assay of Gold. By Lewis Thompson, *Esq., M. R. C. S.*

To separate Lime from Magnesia.

Dissolve the combined earths in dilute nitric or muriatic acid, and precipitate the filtered solution by means of an excess of carbonate of soda; dry the precipitate, and place it in a coated green-glass tube, so disposed that the whole can be heated to a dull red heat; when red hot pass a current of well-washed chlorine through the tube for a few minutes: the lime will be converted into chloride of calcium, but the magnesia remains unacted upon. When the whole is cool, remove the mass from the tube and boil it for a minute or two in water, filter the liquid and wash the insoluble portion (which is magnesia) with water, and precipitate the lime from the mixed liquors by carbonate of soda. The heat should not exceed a dull red, as the mass is apt to become vitrified at the part which touches the tube, and this renders it difficult to remove the contents.

To Assay Gold.

Take six grains of the gold to be assayed and place it in a small crucible, with fifteen grains of silver, and from eight to twelve grains of chloride of silver, according to the supposed impurity of the gold; lastly add fifty grains of common salt (chloride of sodium) reduced to a fine powder so as to prevent decrepitation; fuse the whole together for five minutes, and allow it to become cold; then take out the metallic button and beat it into a thin plate, and subject it to the action of dilute nitric acid as in the ordinary mode of parting. By this plan the tedious process of cupellation is avoided, the baser metals being wholly removed by the chlorine of the chloride of silver, and their place supplied by pure silver. Ibid.

Manufacture of Salt.

The Dutch are remarkably particular as to the quantity and quality of the salt which they use for dairy purposes, and of which there are three kinds manufactured. The first is somewhat smaller than our common salt, and is boiled or evaporated in twenty-four hours. This is used for butter. The second is evaporated in about three days, and is used in salting cheese by outward application. The third is beautifully formed in crystals, of about half an inch square, and the evaparation lasts four or five days. It is sometimes used for salting cheese, but principally for fish, beef, and pork. There appears to be some secret in the process, which the manufacturers are unwilling to disclose; but it is certain, that the use of the Dutch salt is one of the causes of the sweet and delicious flavour of Dutch butter, which hardly tastes of salt, or rather of that acrid quality which the muriate and sulphate of magnesia pervading our common salt impart to our butter. Considering how important an article salt is, it is rather remarkable, that though chemistry has advanced to such perfection, no change has taken place in the mode of making it for several centuries. The late Earl of Dundonald, Dr. Coventry, and the Rev. James Hendrick, proposed important improvements in this manufacture, but they seem never to have been adopted.—*Royal Cornwall Gazette.* Mining Jour.

Action of Æther on Indigo. *By* M. Vogel.

I had more than once remarked by chance that when the vapour of æther is passed into a solution of indigo in sulphuric acid largely diluted with water, it was decolorated. This effect is produced more readily when the æther is heated to ebullition in a matrass furnished with a bent tube which is immersed in the solution of indigo; and if the matrass be suddenly cooled, so that the solution of indigo rises in the tube and passes into the matrass by the pressure of the air. When I attempted on another occasion to decolorate indigo by means of æther which had been rectified over potash, I could not so readily effect it, which induced me to believe that the impure æther, which contained sweet oil of wine, or probably aldehyd, was more fit for the decoloration of indigo than pure æther.

To satisfy myself, I added to a solution of indigo in a bottle a few drops of aldehyd, and I remarked that the liquor, at first of an emerald green colour, became of a pale green, and after some days became of a yellowish brown. As the aldehyd which I employed contained alcohol, it not having been rectified, I afterwards made use of pure aldehyd, which was separated from its crystalline combination by ammonia: a few drops of this pure aldehyd were sufficient to destroy the blue colour of indigo in a very short time, the solution becoming of a straw yellow. When the aldehyd was evaporated by heat, the blue colour could not be made to reappear. The addition of potash, and of red oxide of mercury, were not capable of restoring the blue colour. On evaporating the decolorated liquor there remained a brown substance analogous to ulmin. This decoloration of indigo by aldehyd occurs only when the indigo is dissolved in sulphuric acid. Indigo in fine powder, diffused through water, undergoes no change by aldehyd: neither the tincture of litmus, nor the spirituous tinctures of cochineal or turmeric, are decolorated by aldehyd.—*Journal de Pharm. Mars* 1839. Ibid.

Progress of Civil Engineering.

The Cockerills of Liege.

William Cockerill was a working black-smith, in England. He was constantly bent upon important mechanical designs, which he longed to have the means and opportunity of putting into execution. As often happens, nevertheless, William Cockerill met with little encouragement in the scene of his early labours, and towards the close of the last century, when he had attained middle life, and surrounded himself with a family, he migrated to the continent. Along with some other skilful mechanics, he proceeded, by the permission of our government, to St. Petersburgh, with the view of following out certain plans of the Empress Catherine, for establishing manufactures in her dominions. The death of the Empress, and the accession of the madman Paul, ruined his prospects in Russia, and after a time he made his escape to Sweden. Here, under the protection of the British envoy, William Cockerill was employed as engineer on some public works, which no native Swedes could undertake. Engineering, however, did not suit his genius, and hearing of the manufactures of Liege and Verviers, in Belgium, which were flourishing in spite of defective mechanism, he imagined that, if he were in either of these places, he should be certain to succeed as a constructer of machines. He proceeded first, as we are told, to

Hamburg, where he disclosed the plan of his proposed operations to Mr. Crawford, the English consul—at the same time stating, "that if he could obtain a small pension from the British Government, he would return to England, not wishing to do any injury to his country, by introducing machinery into a foreign one." Mr. Crawford, it appears, approved of the proposal, and communicated it to the Ministry; but no answer being returned at the end of six months, Cockerill proceeded to the Netherlands, there to seek fortune with his own head and hands.

He made offers to some extensive woollen manufacturers of Verviers, a town within the province of Liege, to construct for them new machines of his own invention for the carding and spinning of wool, and for other purposes connected with the production of cloth fabrics. The offers were accepted, and William Cockerill forthwith brought his family from England, and settled with them in Belgium. Cockerill's sons were now growing up, and, with the assistance of their hands and his own, he speedily executed all orders, and founded a thriving establishment. The workshop of the Cockerills at Liege became a famous one, and the quantity of machines made for various manufactures was soon very considerable.

In the year 1813, the elder Cockerill retired from business, with a handsome fortune, leaving his two sons, James and John Cockerill, to follow out his trade. They did so for several succeeding years, and at length James also retired with a competency. John, who was now left alone, and who is said to possess the most enlarged mind of them all, erected, in 1815, the first manufactory for steam-engines which had been seen, on a large scale at least, in Belgium. His machines were soon distributed over the whole continent; but this was done far more extensively afterwards when he erected new iron-works of vast size at the village of Seraing on the Maese, distant a few miles from the city of Liege. The magnitude of this establishment may be conceived from the fact that it keeps in continual motion sixteen steam-engines, of the collective force of 900 horse-power, and employs 3000 workmen. This establishment was organised by John Cockerill between the years 1821 and 1823. Yet, immense as are the operations here conducted, numberless as are the railway projects here perfected, and the steam-engines and machines of all sizes and descriptions here constructed, the establishment of Seraing is but one of the many great concerns which John Cockerill superintends, and of which he is wholly or in part proprietor. He still keeps in action the extensive foundry, originally possessed by his father in Liege; holds large shares in mining and colliery establishments; and possesses large cotton-spinning factories, as well as linen-manufactories, where these stuffs are put into all forms, weaving and printing included. He is also the proprietor of a paper manufactory. All these establishments he in a measure superintends in person, but, at the same time, it is especially remarked of him that he takes care to have the best of servants and overseers, sparing no expense in bringing such persons from all countries of Europe to his various works.

Such are the concerns of John Cockerill, and such are the sources of capital and material which lately enabled him to come forward, unassisted and unrivalled, to offer himself as the contracting party with the French Government for the laying down of a railroad between Paris and Brussels; perhaps the most stupendous enterprise of the kind ever undertaken by an individual. This remarkable man, if we may trust to the accounts given of him, is not stimulated in his career of enterprise merely by a desire of personal emolument or aggrandisement, but seemingly regards himself, and

acts, as one who has a great mission to execute, that, namely, of peopling the world with machines for the spreading of wealth and comfort among its inhabitants.

There are internal meliorations in the condition of the workmen peculiar to Mr. Cockerill's works, and solely due to his sagacity and genius, at once inventive, bold, and benevolent. Such comforts, for instance, as the robing or clothing-rooms, where the workmen hang up their out-of-door clothes when they come, and their working ones when they go away. Every workman has his place marked by a certain number, and a placard with his name. This is transplanting the habits of the business-office into the workshop. But what is most striking is a large hall in the centre of the works, with a stove in the middle of it, neatly ornamented like most of the Belgian stoves; and upon this stove, morn, noon, and eve, there hangs a kettle filled with warm coffee. It is in this hall that all the workmen meet at certain hours of the day, in the intervals of labour, and take their coffee, men and foremen together, the latter holding a certain moral presidence, which the others willingly acknowledge. They here chat without noise or quarrelling, until the sound of the clock calls every man to his duties again.

Lond. Mech. Mag.

Advantages of Anti-friction Machinery. By Mr. Coles.

The lecturer commenced by showing the necessity of all four-wheel carriages being made to move on pivots in the centre of their axles, instead of being fixed and immoveable, *as at present constructed.* He then showed that the off-wheels of an ordinary railway-carriage, when working round a circle of 23 yards radius, would lose 10 inches and a half every revolution they made, *even when working on moveable axles,* and they could not make many revolutions upon any curve without running foul of the rails, and thus the engine would have to contend with an enormous amount of friction; one-half of the wheels of each train would press with their flanges against the rails, as also an increase of friction in the bearings of the axles, by the wheels being thrown obliquely in their bearings.

To obviate which he introduced models of a new step-rail, which may be made of cast-iron, thus: an indentation or step is sunk down on the inner edge of the rail of about one-third its width and half an inch deep in the highest, and about three-quarters in the lowest part. The step of the rail for working curves would be so low down as never to come in contact with the rim of the wheel in working straight lines, nor when working the inner curve. The flange, or largest part of the off-wheel, runs entirely on the step of the rail when working a curve of 23 yards radius; but if working a curve of twice that size it would work one-half on the plain part of the rail, and the other half on the step, which would be undulated, having hills and valleys of equal distance, by which the wheels would run parallel to each other, and thus work clear of the rails and cause no side friction; and rails may thus be formed to suit any curve; the principle of securing the rail to its bearings is both novel and ingenious, and which is particularly described in an "Essay on Locomotive Traveling."

The lecturer then demonstrated more fully his principle of the traversing axles of the four-wheel carriages, from which it appeared manifest that by fixing a stout iron bar to the collars or bearings of the axles, the wheels being outside the frames, such bars would work up and down the grooves with their collars, whilst their axles would revolve in their collars as before

and to these bars two other bars would be attached, something in the shape of a quadrant, which meet each other between the two axles and form a union or knuckle-joint, each part would be operated upon by the rail and thrown diagonally with their axles into right angles with the curve of the rails, room being allowed in the grooves in which the wheels work, to admit of their moving backwards or forwards; the point of resistance is thus transferred from the sides of the carriage-frame to the pivots in the cross-stays on which the axle-bars move; two loops would be attached to the edge of all the axle-bars, about five inches from their collars; the bars being wider than the cross-stays, two bolts would pass through these loops to key them together, and keep them perpendicular over each other, that they shall all move in the same direction.

He next elucidated the foregoing principle of the traversing axles, by exhibiting to the audience a four-wheeled locomotive, with the axles placed into the frame diagonally to such an angle as was required to work round a circular iron railway thirty-four feet six inches in circumference, the off-wheels being seven-eighths of an inch larger in the periphery of the wheels than the inner wheels, which is precisely the same thing as if the periphery of the wheels had been turned both of a size and the flange left on. *The rail and carriages being made on a scale of one inch to the foot.* A two-wheel carriage laden very heavy was attached to the locomotive, and when set in motion they traversed round the circle in five seconds, or at the comparative rate of fifty miles in an hour. He next explained the nature of working them by manual labour, and showed that by fixing a handle to a spoke of the large anti-friction or driving wheel, they may be propelled with immense velocity, the friction being transferred from the ground wheels, which revolve seventy-five times, to the upper wheels, which only revolve once, thereby proving that there would be scarcely any wear in the working wheels. He next exhibited a four-wheel carriage, on which a man propelled himself by turning the wheels as he sat upon it. Mr. Coles then placed 168 lbs. weight upon the carriage, and placed it upon a level iron plane, and attached a six ounce weight and brought it over a pulley which propelled it, the weight was then taken off and the common wheels were employed, and the aforesaid load of 168 lbs. placed upon it, and it required eight times greater power, viz. forty-eight ounces to propel it; thus clearly demonstrating that one pound power is equal to eight pounds now on railways, or sixty-four lbs. *on the common roads,* the advantages are of a like proportion if employed on the common roads, and *this* increase of power is gained by the reduction of friction in the axles alone, leaving for future experiments to show what friction remains to be got rid of between the flanges of the wheels and the rails, which is easily accomplished by the use of a step-rail and traversing axles.

The lecturer further showed that his patent anti-friction machinery is about to be applied to vessels and other machinery, for which he has also a more recent patent, when the combined force of manual labour and steam may be employed with considerable advantage. The steam power to drive one pair of paddle-wheels, and manual labour the other pair, by which two thirds of the fuel may be saved, the motion of the friction wheels being nearly ten times slower than the slowest motion of the carriage wheels, which we need not repeat.

Railway Mag.

Anthracite Iron.

We have again, in our past two Numbers, observed on the increased application of anthracite, or stone coal, which more particularly abounds in South Wales, Ireland, and America. Looking to those districts at home where this description of fuel is most plentiful, it is a matter of surprise that works have not been erected upon an extensive scale for carrying out Mr. Crane's patent for making iron by the use of hot-blast with anthracite. Having had an opportunity some months since, of visiting the Yniscedwyn works, we there saw three furnaces in active operation, the one producing iron from anthracite alone—another having two-thirds of that material, the remaining third being coal of a bituminous nature—and the latter, worked solely with bituminous coal, yielding a weekly "make" of 140 to 150 tons.

The result of our inquiries made on that occasion from the proprietor, whose courtesy it affords us pleasure here to acknowledge, was, that the iron produced from the stone coal was most in esteem, as possessing tenacity and strength, and that the only cause then assignable of any other description of coal being used, was the inability, at that time, of obtaining a sufficient supply of anthracite, which, however, we have reason to believe, has since been removed, and to which our attention has been directed by Mr. J. Johnson, of Liverpool, a gentleman to whom we are indebted, on a former occasion, for an interesting paper "On the Iron Trade." Works were then in course of erection (the Ystal-y-fera) within some six or seven miles of the Yniscedwyn works, which were being carried on by a Liverpool Company, projected, we believe, by Mr. Manby, the (late) engineer, Mr. Budd, of Liverpool, and Mr. Bevan, of Swansea, the latter being the present manager or superintendent, and whom we had the pleasure of meeting on the spot. These works promise to be of an extensive character, and a railway is laid down from the collieries to supply the furnaces, which we were given to understand were to be worked with stone coal, on the principle patented by Mr. Crane. Only one furnace, we believe, is at present in action, and that with a limited proportion of stone coal, in the manufacture of pig-iron or castings. We have not accurately learned the reason, but believe it is attributable to want of supply, and thus not affecting the question of the applicability of stone coal to the manufacture of iron—a fact, indeed, incontestibly proved by Mr. Crane's patent, which has been so successfully carried out at the Yniscedwyn works.

We have not space this week to enter so fully, as is our wish, into detail, but cannot leave the subject without adverting to a matter which, to us, would appear to reflect discredit on the capitalists and iron masters of South Wales generally. We refer more immediately to those connected with the anthracite coal-field. With facts before them, such as must remove the doubts of the most sceptical, strange is it that we do not find the possessors of the mineral or the capitalist disposed to avail himself of the advantages which are so self apparent to arise from a judicious outlay of capital in an immense coal-field, with abundance of ironstone, and possessing the advantage of water communication. How is this to be accounted for?—is the natural question which arises in the mind of every one who gives the matter one moment's consideration; and to this we can only offer one reply, and that so impotent, that we are at a loss to afford those satisfactory reasons which might be expected from us, accompanied by a remedial measure. The only

reason we can advance is the long contested right of patent, and the forthcoming trial of "Crane *v.* Price." It would be improper at this moment to enter into the merits of this cause—suffice it to say, that the Messrs. Price, the defendants, contend that Mr. George Crane cannot maintain his patent, although they are, as must all paties be, ready to admit that Mr. Crane has, at considerable cost of money and application of time and labour devoted to the subject, brought about the successful results, of which the defendants are desirous of obtaining the benefits—the advantage sought by the patentee (we believe a royalty of one shilling per ton on iron) being disputed by them. We know on which side equity and justice lie, but what construction may be put on the Patent Laws, or what quibble may be raised by counsel, we are not prepared to say; and we fear that this contention has prevented parties from availing themselves of Mr. Crane's patent, being anxious to avoid paying so *exorbitant* a royalty, and, therefore, await the issue of the trial.

Mining Jour.

Locomotives on Common Roads.

REPORT OF THE COMMITTEE.

The committee, after some preliminary observations, thus describe the apparatus of the locomotive of M. C. Dietz:—

The apparatus is principally composed of two steam cylinders united to a tube-shaped boiler, similar to those of other locomotives, but with a circular furnace, according to the plan of M. Bury. The action of the steam is communicated by means of two pistons attached to transverse cranks; but the movement does not bear directly upon the axle-tree as in other locomotives; and this is not the only distinction of the Dietz Remorqueur; it bears upon the ground in a manner totally different from other engines. It is hung on eight wheels, six of which are less than the others. The six small wheels are constructed like the castors of a bedstead, and are distributed at each end of the engine, the weight of which thus divided is supported by them. Between each of these wheels and the body of the remorqueur are springs of very great strength, but which are so adapted as to have considerable play. These small wheels may be considered as almost exclusively employed for the hanging of the engine,—that is, they may be forced by the springs into every accidental cavity on the road, and thus they support in a great degree, the principal share of the weight. The six small wheels are connected together so as to assist in guiding the engine by a mechanism which causes the forewheels to converge simultaneously in one direction, whilst the hind wheels are in an inverse position, and it is turned to the right or left, as occasion may require, without any violent effort, by the steering apparatus. In this remorqueur the impulse is given by the adhesion of the two larger wheels to the ground, for which purpose they are not shod with an iron tire in the ordinary way, but are encircled with pieces of wood placed upright in juxta-position, and inserted laterally between two circular pieces fastened to the sides of the felloes.

The wheels are put in motion by means of a strong endless chain; and this kind of motion allows the body of the locomotive to oscillate upon the numerous springs which support it, and to follow every change in the direction of the wheels, without the least disturbance of the mechanism.

On the day of trial the remorqueur, of the construction of which we have ust given the principal particulars, was followed by its tender, and by a large diligence capable of containing a number of persons.

The plan of connecting the carriages with each other is deserving of notice; they are obliged to follow the track of the remorqueur, which is absolutely essential in a long train guided only by the conductor of the remorqueur.

As soon as your committee were seated in the coupe of the diligence, the train started. The resistance at starting was overcome with great facility, and the train proceeded rapidly down the Boulevard Exterieur, which leads to the Invalids. During the progress, either on purpose, or in order to avoid collision with other carriages, the train was compelled several times to move from the paved to the unpaved part of the road, and back again; and this was done not only without difficulty but without any perceptible diminution of speed; and an unexpected obstacle afforded an opportunity of proving the power of the remorqueur, which, in the course of its progress, had to pass over a heap of rubbish thrown out of some excavations which were making in order to repair the high roads.

The experiment was continued in the Champs-Elysées by ascending and descending the slope in the avenue of the Etoile, which is rather steep; and your committee had occasion to remark the ease with which the train turned round to go in an opposite direction. After these different trials, they thought the experiment had been sufficiently prolonged to enable them to judge of the merits of the apparatus submitted to their examination. The excellent way in which it was hung was apparent to them the moment this heavy engine passed over deep kennels without jolting or shaking. The return of the train to the station, through a small gateway in a narrow street, furnished a fresh proof both of the possibility of guiding the remorqueur, and of the skill of the MM. Dietz, brothers, as conductors.

The train passed through the Boulevards, the Champs-Elysées, and even the streets, in the same way as ordinary carriages. The average speed, which was increased or decreased at pleasure, was 15,000 metres (more than twelve miles) an hour; that is a little less than four leagues of 4,000 metres.

Your committee can say nothing respecting the expense of fuel, nor have they received sufficient information to enable them to point out the relative advantages and disadvantages of this system of locomotion, as compared with that of railways, or on common roads with horses. And in bringing under your notice the manner in which this invention of MM. Dietz overcame all the obstacles which it met with, and successfully contended against the practical difficulties of locomotion on common roads, your committee have thought it best to limit themselves to a statement of facts of which they were eye-witnesses, and the truth of which they can attest.—*Inventors' Advocate.*

Railway Mag.

Gas Produced by a New Process.

An experiment in gas-lighting by the Comte de Val Marino was made on Thursday evening on a piece of waste ground at the back of Fetter lane, in the presence of several scientific gentlemen, who were invited to witness the result. A small gasometer was erected for the purpose, which was connected by tubes with a furnace built of brick, and containing three retorts, one of which was supplied with water from a siphon, another was filled with tar, and both being decomposed in the third retort, formed the sole materials by which the gas was produced. The process appeared to be extremely simple, and the novelty of the experiment consisted in the fact, that the

principal agent employed to produce the gas was common water combined with tar; but according to the theory of the inventor of this new species of gas, any sort of bituminous or fatty matter would answer the purpose equally as well as pitch or tar. After the lapse of about half an hour employed in the experiment, during which time the process was explained to the company, the gas was turned into the burners, and a pure and powerful light was produced, perfectly free from smoke or any unpleasant smell. The purity and intenseness of the flame were tested in a very satisfactory manner, and those who witnessed the experiment appeared perfectly satisfied with the result. The great advantage of this sort of gas over that produced from coal consists, it was said, in the cheapness of the materials employed in its production, the facility with which it is manufactured, and the perfection to which it is at once brought, without the necessity of its undergoing the tedious and expensive process of condensation and purification; for in this instance as soon as the preliminaries were completed, the light was produced in a perfect state within a few feet of the gasometer, which although of inferior size, was said to be capable of affording light for ten hours to at least five hundred lamps or burners. With regard to the comparative expense, it was also stated that one thousand cubic feet of gas manufactured by this process, could be supplied to the public for about one-third the price now charged by the coal-gas companies, and it was said to be equally available for domestic use, and more safe than the common gas, inasmuch as small gasometers might, at a trifling expense, be fixed at the back of grates in private dwellings, from which the gas could be conveyed in Indian rubber bags to any part of the house, thereby preventing the many accidents which occur by the use of tubes and pipes. The count de Val Marino, who has conquered the difficulty hitherto experienced in bringing this species of gas into use, superintended the arrangements, and evinced a natural anxiety to bring his experiment to a successful issue. He has taken out a patent for his discovery, and he has improved upon the burners now in use, so as to render the light produced more pure and intense. For this improvement he is also secured by a patent. How far gas of this description can be brought into general use, or whether in point of economy the public would be benefited by its adoption, are questions which we have not the means of deciding, and, without hazarding any opinion on the subject, we can only say that the experiment, as far as it was tried in this instance, appeared to be quite successful.—*Times.*

Civ. Eng. & Arch. Jour.

Artesian Wells.

In a paper on the wells found by digging and boring in the gravel and London clay in Essex, and on the geological phenomena disclosed by them, by Dr. Mitchell, F. G. S., the author gives the following list of the total depth of wells, selected from a very large number:—

Stratford,	247	feet.
Ilford,	301	"
Dagnam Hall,	404½	"
Brook street,	340	"
Upminster,	192	"
Parsonage, Warley,	390	"
Grange Hill, near Fairlop,	398	"
Dunton,	344	"

Battle Bridge, . . .	350	feet.
Ferry-house on the Crouch, .	360	"
Rochford Union workhouse, .	330	"
Wakering Marshes, . .	400	"
Foulness Island { sand, 300 / clay, 100 to 160 }	460	"
Clay street, Walthamstow, .	190	"
Loughton, in Epping Forest, .	324	"
Epping, . . .	270	"
Horsley Park, near Ongar, .	340	"
Bocking, . . .	370	"
Braintree, . . .	420	"

This variation, the author conceives, is partly due to the uneveness in the surface of the chalk; but in some instances to the undulatory nature of the country, the difference in the depth of the wells agreeing with the increase in the rise of the ground. When this is the case, the bed in which the water is found is the same in the adjacent wells, and consequently the variation in the outline of the surface is due to denudation, and not to unequal elevation. Thus, in the two wells close to the turnpike at Romford, water was found at the depth of 100 feet, but half-way up the hill between Hare street and Havering Ate Bower at the depth of 250 feet; at Bocking it was obtained at 370, but at higher ground, at Braintree, close adjoining, at 420. Again, at the union workhouse in Rochford, the well is 330 feet deep, and at Stroud Green, on the road to Rugleigh, where the surface is higher, it was necessary to sink 390 feet. At North Fambridge is a well 388 feet deep, the water rising to within 10 feet of the top: but at another well in the same parish, dug in lower ground, there is a constantly flowing stream.

There is, perhaps, no part of the world where artesian wells are more general, or are more useful than in Essex. In the vale of the Lea they have been bored with the greatest facility and at a small expense. In Waltham Abbey the cost is usually about 16*l*. In the district of Bulpham Fen, seven miles south from Brentwood, they yield a large supply of water. In the marshes, as well as along the coast, and in the islands of Essex, they have proved of the greatest utility. Formerly, in some seasons, when the ditches become dry, the cattle suffered, the fishes died, and the farmer lost severely on his stock; but by the aid of artesian wells the ditches are now kept full all the year, and the farmer and landlord are accordingly benefited. In Foulness Island there are no natural springs, and until lately no water, except atmospheric, collected in the ditches. In hot seasons this water became putrid, but the inhabitants and the cattle continued to partake of it as long as it lasted; and supplies were then obtained, at the distance of seven miles, from the east end of this island. Artesian wells now kept the ditches full of fresh and sweet water, labourers are obtained at reduced wages, and farmers of a higher class are beginning to reside on the island. Wallisea, Mersea, and other islands have profitted in a similar manner.

L. & E. Philos. Mag.

The Electro Magnetic Telegraph of the Great Western Railway.

This telegraph, which is the useful and scientific invention of Mr. Cooke and Professor Wheatstone, of King's College, has been, during two months, constantly worked at the passing of every train between Drayton, Hanwell,

and Paddington. At the former station it, for the present, terminates. As soon as the whole line is completed the telegraph will extend from the Paddington terminus to Bristol, and it is contemplated that information, of any nature, will then be conveyed to Bristol, and an answer received in town in about twenty minutes. Merchants and others, residing not only at the two extremities of the line, but at any of the intermediate stations (at all of which dial plates will be fixed, with competent persons stationed to work the telegraph), will then be enabled to avail themselves of the benefits and facilities of Messrs. Cooke and Wheatstone's invention. Two of the boys from the Deaf and Dumb Asylum in the Kent-road have been at the Paddington station for five or six weeks, where they were instructed in the working of the machinery by Mr. R. Hutchinson, and they are now perfectly competent to superintend the telegraph at any one of the stations. A piece of machinery, simple but unerring, to which is attached a check-string to indicate to the boys when the signal is sent up to the line to show that something is about to be telegraphed, has been invented by Mr. Cooke, which enables these lads to perforn this duty as efficiently as if they were not suffering under the deprivation of hearing and speech. The telegraph has now been in operation for nearly twelve months, and not the least obstruction to its working, by any of the wires, &c., becoming out of order, has yet occurred. Should such an event take place (especially when the whole line is open to Bristol) it might occur to many that there would be considerable difficulty (as all the wires are enclosed in a hollow tube, not more than about an inch in diameter) in ascertaining, throughout the 117 miles, the precise point at which the injury required to be prepared; but this apparent difficulty has been met by Mr. Cooke, who has invented a piece of mechanism which is contained in a mahogany case, not more than eight inches square, by which means the precise spot on the line where the injury might have been occasioned, would be indicated in an almost incredibly short space of time. The invention may now be termed perfect in all its details, and only awaits the completion of the line of railway to Bristol to bring it into full operation between that city and the metropolis.

Mining Jour.

Gates for the Crossings of Railways.

Mr. T. Lambert of Stockton-upon-Tees, has constructed a neat mode for gates, to be used at the crossing of railways. The gates turn on centres; and are so simple and complete, that one man can open both of them at one time with the greatest facility. When open, they prevent any one passing on the railway, and admit the progress of carriages, carts, etc., on both sides of the turnpike. Each gate is also furnished with an elevated circular signal, containing a lamp, which turns with the gate, so that whether it be night or day, persons at a great distance will be enabled to see when "danger" is announced. We have had the pleasure of examining the model, and can say with truth, that the invention seems to effect every thing necessary for the protection of life and property at crossings, while it allows the greatest facility for passing on the road.—*Sunderland Herald.*

London Mech. Mag.

Railroads in Austria.

M. Zanino Volta, the able engineer of Como, who, in conjunction with M. Bruschetti, of Milan, obtained, in 1837, from the Austrian government, a

privilege of fifty years for the construction of a railroad between Milan and Como, is now negotiating with the Swiss cantons of the Grisons and St. Gall an enterprize which would vie in magnitude with the Thames Tunnel, viz. the piercing through the Grisons' Alps. Impressed with the commercial importance of the passage of the Splugen, and at the same time with various obstacles which it presents, he thinks it possible to pierce through that mountain, and establish in the passage thus effected a railroad, the northern portion of which would end either at Wallenstadt, or even at Schmerikon, on the lake of Zurick; and the southern would be connected with the Como and Milan Railroad. M. Volta does not dissemble the expense and difficulties of such an undertaking, but insists on the immense advantages that would accrue from a horizontal road accessible at all times, and not nearly so long and fatiguing as the present one. As galleries above half a league long have already been bored, he deems that there is no reason why longer still should not be pierced. An examination has proved that the granite rocks to be gone through can be easily blown up, and that by a new process the operation may be rendered easier still. M. Volta, reckoning that thirty years will be required to execute the works, demands an exclusive privilege of a hundred years, with liberty to establish companies in order to procure funds or to transfer his privilege to other parties. In return he engages to execute 8000 metres in the course of five years, and the whole line, crossing the territory of the Grisons and St. Gall in thirty years. Moreover, M. Volta engages to pay 10,000 francs into the cantonal coffers of the poor for every year of unjustified delay in the construction of the first kilometre, or proportionately in the completion of the whole road over the Swiss territory, or else to resign entirely his privilege. Mining Jour.

Fire Damp.

It has been found by experience, that Sir H. Davy's safety lamp, though in many respects an invaluable discovery, has failed in proving a preventive to the explosion of fire damp in coal pits; and the frequent recurrence of accidents in the mining districts, evince the melancholy truth, that the precautions hitherto devised are incomplete. I venture therefore to propose a new process for abating an evil so fatal to human life, which is at least worthy of trial. It is well known, that fire damp explodes on ignition by an electric spark; and on this principle it is proposed, that an experiment be made with an apparatus consisting of Professor Daniel's voltaic battery and electrical wires, for the purpose of firing the gallery of a mine charged with an explosive mixture. By means of this ingenious and scientific contrivance, an explosion of fire damp can at all times be effected with perfect safety, whenever the gas is evolved in sufficient quantities to generate this destructive element; and as the wires can be conveyed to the remotest chamber of the mine at a trifling cost, the experiment may be repeated with great facility by the aid of a powerful battery, in any place where it indicates its appearance, or creates a suspicion of danger. The actual presence, quantity, and position of the fire damp, can always be ascertained with precision and certainty, through the agency of the safety lamp; but care must be taken that the carbonic acid and azote remaining in the mine after the inflammation, be got rid of, either by decomposition, absorption, or ventilation, before the workmen resume their labours. This formidable and treacherous enemy will thus be effectually and instantaneously annihilated, that

otherwise could be but slowly, partially, and progressively consumed, combined with the advantage, that the health of the miners will cease to be impaired from respiration in a foul atmosphere. Athenæum.

Progress of Physical Science.

Experiments and Observations on the Temperature of Artesian Springs or Wells, in Mid-Lothian, Stirlingshire, and Clackmannanshire. By Robert Paterson, M. D., M. W. S. Communicated by the Author.*

Coal being the object of most general search amongst proprietors in this country, its presence has been long ascertained by making perforations into these strata. In the course of these borings, it frequently happens that, after passing through a series of layers which are impervious to water, they come upon one from which it exudes abundantly, occasionally spouting to a considerable height from the mouth of the bore.

Thus, in an instance which Mr. Johnston of Meadow Bank, near Falkirk, has been kind enough to communicate to me, upon boring to the depth of 414 feet from the bottom of one of his coal-pits, the rush of water was so great as nearly to inundate the pit, and was with great difficulty stopped for a time by inserting a wooden plug into the mouth of the bore. This, however, also proved insufficient, the pug being expelled with great force by the upward pressure of the water. The number of these springs throughout Scotland is now considerable, and, since public attention has been turned to them by M. Aragot† and others, and more especially to the fact that they are the surest means of deducing the rate of increase of the internal temperature of the earth, they possess an additional interest.

If the water, as it makes its exit from the mouth of a bored well, possesses a temperature above that of the surrounding atmosphere, it must have acquired that temperature from the rock out of which it came. But two very important objections have been urged against its possessing precisely the same temperature as the rock which contained it. *First*, That frequently springs coming from a higher level mix, and consequently modify the temperature of the water. *Second*, That water coming from a great depth, loses a certain degree of its temperature in imparting it to the cooler sides of the perforation.

That such objections might not be brought against this species of information, we used an instrument which has been long known for ascertaining the temperature of water at great depths. It consists of a glass-tube with brass ends which screw on; in each of these ends there is placed a valve, and both of the valves open upwards. It contains a thermometer, and is surrounded with a non-conductor; a string being attached to it, it is lowered down into the bored well. The water rushing up the bore, together with the instrument descending against it, causes both valves of the instrument to open, by which a free communication through the instrument by the valves is kept up, until it reaches the bottom of the perforation. The instrument is to be allowed to remain there for a short time, and then withdrawn as quickly as possible. As soon as we begin to withdraw this instrument, the valves close, and consequently include a quantity of water from the lowest level, at which it has been.

* Read before the Wernerian Natural History Society, Jan. 12th, 1839.

† See Professor Jameson's Journal, vols. i. xviii. xix. xxiii. xxiv.

We have used the above described instrument on many different occasions, and in many different artesian wells, both those of recent and of several years formation, and on no occasion did we find the slightest difference of temperature, between the water taken at the mouth of the bore, and that brought up by the instrument.

In all springs, therefore, of this description, in which we can tell the depth from which the water comes, we may safely rely upon the temperature of the water at the mouth of the bore being similar to that at the bottom of it, and consequently of the stratum from which it came. And, in those instances in which we have reason to suspect that the water is mixed with springs from a higher level, the use of an instrument similar to that above described will settle the question.

Our first experiment was made on an artesian spring in the immediate neighbourhood of Edinburgh. When the brewery at Meadowbank (the place to which we refer) was erected, a well was sunk to about forty feet from the surface, for the purpose of supplying the establishment with water; in consequence, however, of the supply proving deficient, the proprietors were recommended to sink a bore from the bottom of the well. This was accordingly done through different coloured clays, sands, and very thin strata of fragile sandstone, to the depth of 119 feet, till they reached a considerably thicker and firmer stratum of sandstone, from which the water filled the bore and gushed over its edges. The supply has since continued, and proves amply sufficient for the great consumption of the brewery.

The well into which the water of this bore is allowed to enter is soon filled, in consequence of the large quantity of water emitted by the artesian spring. It will, therefore, be obvious that opportunities of testing the temperature of water, at the mouth of the bore itself, do not often occur. Through the kindness of Mr. Aitken, however, I was enabled to do this, and found the temperature of the water to be 49¼°, and which temperature, of course, would have been the same had it come to the top of the well. This well, as we have already stated, is 40 feet deep, therefore the temperature of this water was that of the rock 159 feet below the surface.

[After describing a number of wells with some account of the various strata bored through, the author proceeds:] We may remark that artesian wells are abundantly to be found throughout the rocks of the coal-formation. This is a fact not at all to be wondered at when we consider the variety of rocks which are to be found in that series, some of which are pervious, and others impervious, to water. Indeed, so well is this known in some parts of the country, that preparations have always to be made before commencing a perforation, so that they may be enabled to stop the flow of water from it, in consequence of the water proving a nuisance to the land in the immediate neighbourhood, if it is not wanted for economical purposes.

The quantity of the water which flows up these peforations is very various, generally bearing a proportion to the width of the bore, and the depth to which it is carried. In some of those which we have mentioned, the quantity of water is very considerable, coming out of a bore nearly three inches in diameter, in a full and continuous stream; and I am informed by Mr. Johnston of Meadowbank, who continued boring to the depth of 69 fathoms (414 feet) from the bottom of one of his coal-pits, that at that depth the rush of water was so great that they were obliged to stop the boring operations. The quantity of water ejected by this bore has been roughly calculated by Mr. Johnston, to be about a hogshead per minute. The

quality of the water is excellent, and is used by many families in the neighbourhood of these peforations in preference to the surface springs. It, in general, contains a quantity of the hydrate of iron, received probably from the strata of ironstone through which it has to pass; this however, is soon deposited by the water in the shape of a hydrated oxide, on the bottom of the water-course. In some instances, however, the quantity of iron is so great as to constitute it a slightly chalybeate spring.

It is a curious fact connected with the artesian springs of Clackmannanshire, that some of them, and more especially those of least depth, emit a much larger quantity of water when the tide is high. This is a remark which has been made by Mr. Bald, and by various individuals in their neighbourhood. It is very evident that this increase in the quantity of the water given out by the spring, has a connexion with the rise of the tide, and has been most commonly, and in our opinion very properly, referred to fissures extending into the strata, and to which the sea-water has access. That no salt water can extend along these fissures is proved by the fact, that these artesian wells are never brackish; but to account for this, it has been supposed that the percolation through the strata is sufficient to remove the salt; this, however, cannot be, as no percolation which we are yet acquainted with, enables us to remove the saline ingredients of sea-water. We are, therefore, inclined rather to explain it after the following manner:—These fissures extend, as we have formerly mentioned, through the stata into the bed of the river; these, however, are constantly discharging water into the river, the quantity of which, however, must materially vary according to the superincumbent pressure. Thus, when the tide is high, the quantity emitted by the fissure into the river must be considerably less than when there is only a small quantity of water in the river. Now, if there is a constant discharge of fresh water from this fissure, we can easily understand that, according to the laws of hydrostatic pressure, the quantity emitted by the artesian spring when the tide is high, is just so much greater as the quantity of water emitted by the fissure into the river is less. This, it appears to us, will sufficiently explain the phenomenon, without the supposition that percolation, or any other process, removes the saline taste of the sea-water.*

We now come to consider the increased temperature which these artesian wells are found to possess.

When we look at the experiments which have been related in a former part of this paper, we cannot but be struck with the similiarity of the results, as deduced from localities far different from each other; such a result cannot be accidental, and cannot be explained by causes of a local nature, but must be produced by some general agency, which extends over the whole surface of the globe, and which is now believed by the generality of geologists to be the central heat of the earth.

It was long ago advanced by M. Arago, that Artesian wells were the only sure way of arriving at any correct data by which to judge of the increase of temperature as we descend in the crust of the earth. The temperature of mines had previously been much attended to, but the results were found so various, and the sources of fallacy so numerous, that no cor-

* There are natural artesian wells (springs) of excellent fresh water on the borders of some of our salt marshes. It would be interesting to ascertain whether the flow of water from them is affected by the tide, and to what extent, and also whether the depth of water in wells near the sea coast varies in many instances with the tides. Communications on the subject will find acceptance in our pages. G.

rect data could be based upon them with any confidence. In reviewing our experiments, it will be obvious that they bear upon two very important topics connected with this subject, and these are, *first*, the rate of increase as we descend, and *secondly*, the regular ratio which it bears.

This latter point is distinctly shewn by observing the temperature of artesian wells of small depth, and comparing them with those of great depth. Indeed, so much can this be depended on (at least in the districts we have examined,) that on several occasions when individuals totally unacquainted with the subject have been told the mean of the district, and the usual rate of increase which had been found in other springs in that neighbourhood, as well as the depth of the spring we were about to examine, they have told the temperature very nearly.

The use, too, of the instrument before mentioned, renders our calculations upon the regularity of the increase very satisfactory.

We shall subjoin, in a tabular form, the result of our experiments on the temperature of the artesian wells, and the rate of increase as we descend.

List of the Localities, Temperature, and Rate of Increase of the Artesian Springs, mentioned in the present communication.

Name of place.	Temp. of Spring.	Temp. of District.	Depth of Spring.	Rate of increase.	
	°	°	Feet.	°	Feet.
Meadowbank	49½	46½	159	1 for every	53
Kerse	51½	46	231	1 "	42
Mumrills	51	46	213	1 "	42.7
Loanside	48	46	100	1 "	50
Kennetpans Distillery Bore	51½	46	270	1 "	49.1
Spring immediately under Mr. Bruce of Kennet's house	53	46	350	1 "	50
The 4 springs here noted are in the immediate neighbourhood of Kennetpans, and quite close to the roadside.	51	46	210	1 "	42
	49	46	160	1 "	53.1
	50¾	46	200	1 "	42.6
	51	46	210*	1 "	42
Parish of Slamannan†	48	45	180	1 "	60
			Average	1 for every	47.11

A simple inspection of this table will shew how very nearly the results of different localities approximate; and if we take the average number of these results, 1° for every 48 feet as we descend, we shall find that it comes very near the average, as fixed upon by the British Association, which is 1° for every 45 feet of depth. On comparing this table with the following, which has been drawn up from a variety of sources, but more especially from papers which are to be found in Professor Jameson's Journal, we shall find that the average of the former is much less than the latter, and this chiefly in consequence of some of the observations we have quoted having been made on enclosed waters at the bottom of old pits. We have altogether

* This is the supposed depth; accurate information regarding it could not be procured.

† Mr. Kincaid has furnished me with this observation, on which perfect reliance can be placed.

kept out of the experiments of Spasky and Kupffer on the artesian wells of Vienna, as there is certainly some mistake, or rather, as Professor Bischof remarks, some militating cause, and he conjectures "that the depths of these springs are not equal to the lowest point of the course of the spring, but that the springs rise from a still greater depth."

			Feet.
Rüdersdorf (Magnus and Erman,)	1	in every	48.3
Later observations,	1	"	51.2
Still more recent,	1	"	54.1
* Erzgebirge (Bischof,) from observations on enclosed waters,	1	"	61.8
* Monk Wearmouth,	1	"	59.7
* Cornwall, from springs,	1	"	54.8
* Cornwall, from enclosed waters,	1	"	52.7
* Uralian Mountains, from a comparison of the most authentic observations in these regions,	1	"	55.4
* Rüdersdorf, from rising springs,	1	"	54.4
Paris, Well at Port St. Ouen,	1	"	72.1
Departments du Nord, et du Pas de Calais, Well of Marquette,	1	"	61.
Aire,	1	"	41.
St. Vincent,	1	"	47.
Sheerness,	1	"	41.
Tours,	1	"	41.8
Geneva, (De la Rive et Marcet,)	1	"	50.
Paris, Slaughterhouse of Grenelle,	1	"	57.1
Average,	1	for every	53.1

Edinburgh New Philosophical Journal.

On the Cause of the Holes that occur perforating sheets of Melting Ice. A Prize Essay in the Chemical Class, Marischal College, Aberdeen, Session 1837-8. *By* JOHN FERGUSON, *of Nigg, Student of Medicine.*

The holes in question are generally about one or two inches, and sometimes more, in diameter. In shape, they are more or less round, but seldom completely cylindrical. In direction, they are most commonly perpendicular to the surface of the ice. After a thaw, they may be readily seen in the sheets of melting ice that float down a river, or on the sea-shore near its mouth. They occur not only in very thin sheets of ice, but in ice upwards of three inches in thickness; and not only in ice disintegrated by melting into a porous texture, but in ice apparently the most compact.

In order to ascertain the cause of these holes, the structure of ice was first considered. Depressions, especially in the under surface of ice, may be observed, and, at such depressions, it may be supposed that the ice will melt into holes; and this in fact happens. But the holes thus formed are seen only in ice less than half an inch in thickness, they are bounded by thin sharp edges, and they are seldom round, so that they do not at all resemble those that are the object of the present inquiry.

Air cells, which are to be found in all ice, varying greatly in their size and frequency in different pieces, but in both respects very equally distributed in the same piece, may also produce small holes in very thin ice;

* Copied and reduced from Professor Bischof's paper on Thermal Springs.

but these are easily distinguished from the larger holes in question, which, as has already been mentioned, occur in ice, although thick, and whether porous or compact.

Ice, in freezing, has a tendency to assume a crystalline structure, which, were it to differ in any one part from the rest, might, in such part, occasion a corresponding facility in the melting. Yet no such difference was detected by inspecting newly frozen ice; and pure newly frozen ice was observed to melt by a warmer atmosphere, or by the sun, without forming any of the holes in question. Ice, indeed, while melting, sometimes appears to consist of a number of prisms laid loosely in apposition, and directed perpendicularly to the plane of the sheet. But I could never succeed in driving any one of these prisms through into a hole, without, at the same time, breaking the surrounding ice. Besides, the holes to be explained are not peculiar to ice of such structure.

As none of the circumstances attending the formation of ice seemed to account for the appearance of the holes in question, attention was next given to ice during the process of melting. After the formation of ice, indeed, and while hard frost continued, nothing rudimental of a hole could ever be observed. Thus the question came to be, What circumstance in the melting gave rise to the holes?

Their frequent occurrence in ice at the mouths of rivers might suggest the idea of their being dependent on salt water—a conjecture supported by the well-known effect of salt in lowering the freezing point of water, and its consequent power of melting ice. The holes, however, occur in inland pools, and in rivers at a distance of several miles from the sea. I froze sea-water by exposing it during a very cold night to radiation—the natural freezing agent. When the ice thus produced was melted, in almost every natural manner, none of the holes were formed, but only a spongy porous texture, in consequence of the rapid melting apart of almost all the ice impregnated with saline substances. I also immersed common ice in sea-water, where the melting took place more rapidly than in fresh of the same temperature, but, in other respects, little, if any, difference of action was observed. From these and similar considerations, I inferred that the formation of the round holes is little dependent on the presence of saline substances in considerable quantity—much less in the exceedingly minute quantities held in solution in ordinary fresh water.

The remarkable property of becoming specifically heavier, as it ascends in temperature from 32° F. to 38° F. belongs to water. On account of this property, water lying in a depression on the surface of a sheet of melting ice, would obviously undergo a circulation, the portion heated by the air descending in the centre, and, when cooled by ice at the bottom, rising by the sides. The immediate consequence of the warmer water being thus always conveyed to the bottom, would be to melt the ice at that part, and thus produce a hole. But when a depression was made in a sheet of ice, and water put into it, the depression, so far as I could observe, continued of the same depth during the whole time of melting. Hence, in such circumstances, the ice probably received the heat as fast as the water.

After having thus far failed to account for the appearance in question, I made an observation that indicated what seems to be the real cause.

In the course of my observations on ice melting on the sides of rivers, I frequently saw holes not entirely perforated through the ice. In the bottoms of these, I always observed solid bodies—stones, dust, sand, bark of trees, or the like. In one instance, of which I had taken particular notice,

I subsequently observed that the imperfect hole had been rendered complete, and corresponded in size to those, the cause of whose formation I had been attemping to discover. I then placed a stone above a piece of ice during sunshine, and examined it on the following day, when a complete hole, bigger than the stone, was found in the ice below the place where it had rested. I confirmed these observations by experiments repeated under varied circumstances, always with like results. Thus, having placed upon ice almost all such small bodies as are usually found on the sides of rivers, I exposed it, in order to melt, both in the rays of the sun and in a warm atmosphere. In all the experiments holes were produced. I have also seen, where two sheets of melting ice were lying, one above the other, a complete hole through the upper, and an incomplete one through the under sheet, continuing the upper hole, and having at the bottom a bit of clay. Under the same circumstances of temperature, holes were produced when the bodies were put below the ice, so as to allow it to rest on them; and when dust, crumbs of brown wood, and other such light substances, were placed below, they rose up, by capillary attraction, as the holes upwards approached the surface, always keeping the top of it, till the holes were completed. After exposure for one or two days, the holes produced in my experiments, as also those whose formation I had watched, were, by continued melting, ultimately smoothed into the same appearance as those for whose origin I had been seeking to account.

The principle on which these foreign bodies act in producing holes, is their possessing the property of absorbing radiated heat in a higher degree than ice. That this explanation may be applicable to cases in which the body has sunk so far into the ice as to be out of the reach of the direct rays of the sun, or has been originally below the ice, it is necessary that ice should give passage to the heat of the sun's rays. That ice has this property, was determined experimentally. I took a sheet of pretty transparent newly frozen ice, fully half an inch thick, and having smoothed the inequalities of its surfaces, I found that I could inflame a piece of sealing-wax, by concentrating on it the rays of the sun, by means of a burning glass, whether the ice was interposed between the sun and the lens, or between the lens and the wax. The effect, indeed, seemed to be little diminished by the interposition of the ice. Yet, that ice does not transmit heat altogether without interruption, appeared from the possibility of melting a hole in the most transparent ice by the same lens. Hence it appears that heat, radiated from he sun, will pass through ice, with little interruption, to any opake foreign body, by which it will be absorbed, and by which it will be communicated, by conduction, to the contiguous ice.

The sun is evidently not the only source of the radiated heat absorbable by such foreign body. Thus, we can scarcely suppose that all the sun's heat is intercepted by the clouds, even in a day the most overcast, as such a circumstance never happens with his light; and, when ice is melting in a warm room, not only the fire, but the walls and furniture, are sources of radiant heat. The natural exposure appeared to be most favourable to the formation of the holes; for, in the rays of the sun, a sheet of ice, with a stone above it, was often entirely perforated before the sheet had melted a quarter of its thickness, while in a warm room, it would first have to melt nearly half its thickness. Perhaps the reason was, in part, the more equal action of the heat derived from the atmosphere by conduction, and, partly, the greater absorption by the ice of heat radiated from terrestrial objects, than of heat emanating from the sun.

The explanation of the form of the holes will now be easily understood. As the bodies that produce them, generally either are of themselves round or oval, like most of the small stones found on a river side, or are collected by the washing of the water into circular heaps, as in the case of sand, it is evident that the holes must, from the first, tend to assume a circular form. But, as an additional widening of the hole, during and after its formation, always takes place, owing to the continued melting of the ice, the first irregularities become ultimately less observable. The holes are seldom of equal width throughout, being sometimes wider above than below, at other times the reverse. The foreign body that forms the hole has originally descended, when the hole is wider above—the first formed part of the hole being widened by its longer subjection to the common melting that the whole sheet undergoes—and, in the reverse case, the body has been below the ice, and has ascended.

I have never observed any of the holes, not completely perforating the ice, without having at its bottom some opake foreign body. The holes, during their formation, take a direction perpendicular to the horizon; and the occasional obliquity of the holes, in reference to the surface of the ice, is to be accounted for by their having been formed when the sheets lay in a position oblique to the horizon.

Before the breaking up of ice by a thaw, the holes most usually are to be observed at the sides of rivers. Indeed, I have scarce ever seen them in the middle. After the breaking up of ice by a thaw, several circumstances serve to increase the number of holes. On the sides of rivers, there is generally a collection of small round stones. Upon these, sheets of ice, when floated up by the rise of the tide, are left, and, during the thaw, soon become perforated with holes upwards. If such holes should not be complete at the time, they are rendered so by subsequent melting. As the stones, in such situations, frequently rise an inch above the surrounding level, they may perforate holes in ice an inch thick. The holes in ice of greater thickness, are commonly produced by bodies lying above the ice, such as the small stones that are washed upon the ice by the agitation of the water, or bits of bark, or of brown wood. Such light bodies, when they float, sometimes produce holes upwards, by being placed below the ice. Holes break out, also, wherever light bodies have been frozen into ice, as occurs in almost every situation. Collections of sand, earth, or clay, constitute another very usual cause of holes.

Standing waters afford peculiar occasion for foreign solids to produce holes in its ice. In a pool, where small single blades of grass had been frozen into ice of two or three inches thickness, I have observed that, during a thaw, the ice immediately surrounding the grass melted into a round hole, often an inch or two wide; and, in ice upwards of three inches thick, where a few withered rushes—one here, one there—were frozen, in a horizontal position, in the middle of the ice, every rush, after a few days' thaw, had a space around it, large enough to hold ten rushes. The vital heat of the grass may have contributed to the melting; but the dead rushes could only have acted like any other opake inorganic solid.

Holes of a similar origin to those in ice, accounted for in this Essay, occur also in melting snow, where dust, or other opake solid has lain on the surface.

L. & E. Philos. Mag.

NOTICE FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

Whether plants acquire Azote from the Atmosphere. By M. BOUSSINGAULT.

I shall examine in this second memoir, whether plants, which are fully developed, and endowed with a complete organization, assimilate azote when transplanted and cultivated in a soil absolutely deprived of organic matter.

The experiments that I made last year prove that clover, sprouted, (né) and cultivated in sand previously calcined, admits, in its organization, a certain quantity of azote, derived, very probably, from the atmosphere. I this year raised peas under similar circumstances, and obtained the same results; and proved what was rather an unexpected fact, that peas under the influence of this regimen, having no other aliment then water and air, will bloom and bring their fruit to perfect maturity.

Five peas, weighing together 1.211 grammes, and each having the same weight, were sown on the 9th of May, in clay previously calcined to redness and then moistened with distilled water. They were placed in a closed pavillion, and with the precaution of preventing the access of any dust that might be floating in the atmosphere. On the 16th of July they had a fine appearance, were in blossom, every pea producing a stalk and each stalk a flower. On the 15th of August the pods were ripe. We then ceased to water them, and at the end of the month the plants had become dry. The length of the stalk was from one to one and a quarter yard, but very slender, and the leaves were but about one-third the size of those raised in a manured soil. The pods were about one and a quarter inch long and nearly half an inch wide. Four of the pods had each two peas in it; the fifth but one, but its size was nearly double that of the others.

The composition of the peas, after being dried in a vacuum of 110° (= 230° F.) was:—

Carbon,	53.5
Hydrogen,	6.6
Oxygen,	33.8
Azote,	3.5
Ashes,	2.6
	100.0

The stems and pods dried in the same manner (the ashes being deducted) contained,

Carbon,	52.8
Hydrogen,	6.2
Oxygen,	39.4
Azote,	1.6
	100.0

The result of the experiment was:

	Grammes.		Carbon.	Hydrogen.	Oxygen.	Azote.
Peas planted	1.072	containing	0.515	0.069	0.443	0.046
Produce	4.441	containing	2.376	0.284	1.680	0.101
		Difference +	1.861	+ 0.215	+ 1.237	+ .055

Hence 1.072 grammes of peas gained 3.369 grammes of organic matter in ninety-nine days of growth during the warmest months of the year; and we find that the azote in the seeds sown was more than doubled in the produce.

2. From a field of clover sown in the preceding year, the author selected several plants of the same height. The adhering earth was removed from the roots by careful washing in a fine stream of water; the plants were then dried by pressing them with blotting paper and by exposure to the air during severaldays. Three of them were retained for analysis, and three others were immediately planted in sand recently calcined and moistened with distilled water, and placed so as to be sheltered from dust. They at first languished, but soon afterwards became remarkably vigorous. In the course of a month their height was doubled; the leaves had a good colour, and they appeared as well as those of the plants which grew in the open field. About the 8th of July the flower began to appear, and by the 15th had assumed a flesh colour. The watering was discontinued on the 1st of August that the plants might dry.

The roots were very little extended, their extremities were very hairy, but the knotty portion which constitutes the body of the root had made no progress. The plants were gathered, cleaned, dried, reduced to powder and analysed in the same manner as were the peas.

The author afterwards treated several plants of oats in the same cautious manner, and we thus sum up the results of his experiments.

1. Peas planted in a soil absolutely sterile and watered with pure water, acquire complete development, pass through all the phases of vegetation, and produce fruit perfectly mature. Azote constitutes one of the aliments derived either from the water or the air, and assimilated by the plant.

2. Clover taken from a fertile soil, and afterwards cultivated without the presence of dead organic matter, likewise gained an accession of azote.

3. Oats taken from a manured soil and placed in the same condition as the clover, acquired from the air, carbon, hydrogen, and oxygen without assimilating any azote; the analysis, on the contrary, indicating a slight loss of that principle.

The researches I have undertaken appear then to prove that under various conditions certain plants are disposed to derive azote from the atmosphere. But in what circumstances, and in what state azote becomes fixed in vegetables, is a question which we are yet unable to decide.

In fact, azote may enter directly into the organism of plants, if their green vessels are adapted to its combination; or it may become a constituent in them, through the water which always contains air and which is inspired through the roots. Finally it is posssible, as many philosophers are of opinion, that there exists in the air an infinitely small quantity of ammoniacal vapour.

Annals de Chem., Dec., 1838.

Geology of the Moon.

Capt. Portlock, President of the Geological Society of Dublin, being of opinion that information as to the original condition of the surface of the earth might be obtained by an inquiry into the condition of some other planetary body, wrote to Dr. Robinson, of Armagh, on the subject; the following is the Doctor's interesting reply:—

Observatory, Armagh, Feb. 7, 1839.

My Dear Sir,—My general notion is, that you are quite right in refer-

ring to the moon as evidence of the absence of weathering. The sharpness of its rocks and peaks is quite surprising; for every angle and edge stick out with a ruggedness that is, perhaps, the thing which first strikes an observer with a sense of the wide difference between that globe and the earth. It alone would show that air and water are absent, had we no other evidence. But you are, I think, in error, when you infer from the great height of lunar mountains, the probable quantity of the wearing down which our earthly peaks have suffered. The moon has less attractive force than belongs to our planet, so that the same elevating force would do about twenty times as much work; and there is every reason to believe that the elevating forces were far more energetic. Indeed, I regard the appearance of the moon as strong presumption against Mr. Lyell's notion, that the energy of volcanic action is as powerful now as it was in the primeval epochs of our planet. No volcanic action is now at work in the moon; but we see that it was once raging with uncontrollable fury, and on the most prodigious scale. There it has actually worn itself out; here, I think, we may assume that it has merely expended most of its force. I may here tell you some of the matter which I see, or think I see, on the surface of our satellite. The mountains of earthy shape are some pretty high, the highest peak of the said Apennines being, according to the best authority, something under 17,000 feet above the plains from which it rises; but this is a rare instance, and very few reach 6000. They are of astonishing steepness. But the Ring mountains, or craters, are much stranger affairs. Take, for instance, Tycho, that bright spot in the south-east quarter, from which the rays seem to run. It is fifty miles in diameter, and 16,000 feet deep, surrounded by broad terraces within, and with a central mountain about 5000 feet high.

This is the type of the principal part of the lunar mountains; some are 200 miles diameter, and one nearly of this latter size, 22,000 feet deep. What a paroxysm it must have been that hollowed out this monstrous crater. Observe that all these craters are depressed below the lunar surface, the elevation of their walls above it being in general but half their depth below it; and the question is, what becomes of the immense quantity of materials that must have been blown out of them. Schroeter thought that the walls, if demolished, would fill the cavities; but this (in Tycho, for instance) is certainly not always the case, and we do not recognise heaps of debris in the vicinity. But we do find a curious appearance sometimes—those rays to which I have already alluded as diverging from particular craters. They are peculiarly bright, but not at all elevated above the lunar surface, and give the idea of a fluid which had run out in currents, and produced some chemical change in the soil over which it passed. As these rays are themselves bristled with craters, these latter must have been of subsequent formation. The long lines terminating in those dusky places, which we sometimes hear called seas, have perchance been rivers; but as they generally seem to originate in some crater they were more probably the track of volcanic fluids, which, however, must have been quite different from our lava, and, perhaps, have played some part in the absorption of the lunar at-

mosphere, and the removal of its seas. In general the large craters are far more brilliant than the other parts of the moon, and the comparative obscurity of the seas arises from the scarcity of volcanic action there. On earth, I believe, our present volcanic products are but little reflective; it is otherwise there; but it may be remarked, that the small craters, which subsequently broke out on the greater and older ones, are much less bright, as if the expiring action had been more analogous to that of our own planet. But this at least is clear, that since the invention of the telescope the moon has been undisturbed. But I must stop by assuring you that I am yours sincerely.

T. R. Robinson.

Mining Jour.

Mechanics' Register.

The Daguerreotype.

A curious application of the Daguerreotype, is to be made at the opening of the railroad to Courtrai, Belgium, if the weather be favourable. The camera obscura is to be placed on an eminence commanding the royal pavilion, the locomotive engine, the train of wagons, and the major part of the *cortège*, and is to be brought into action exactly at the time of the delivery of the inauguration speech. A discharge of cannon is to be the signal for a general immobility, which is to last the seven minutes necessary for obtaining a good representation of all the personages present. The plate is afterwards to be enclosed in lead and deposited under the first stone of the foundation of the station at Courtrai.

Mining Jour.

Elkington's Patent Mode of Gilding by Immersion.

The ordinary gilding process is well known. An amalgam is formed by rubbing together gold in a comminuted state, and quicksilver. With this amalgam the article to be gilt is covered, and being then exposed to heat, the mercury exhales, and the pellicle of gold remains. The mercurial vapour is condensed, and, thus recovered, is again and again applied to use. By the new process, the gold is dissolved in what the older chemists used to denominate *aqua regia*, with which is mixed one of the combinations of potash. The solution is heated, in order, we suppose, that it may suspend a greater quantity of metal than it would do if cold. At the model room a small spirit lamp was used for the purpose. The copper, or other article, is cleaned by successive washings in acids of diminishing strength, and, lastly, in pure water; it is then dipped in the saturated solution for a few seconds, again washed, as before, and in half a minute the entire process is over, and it is presented to the spectator, beautifully gilt. The gold is deposited on the same principle that crystals shoot upon a rod or string. For single gilding one dipping is required, when a thicker coat is necessary, the dipping and rinsing is repeated.

Lond. Mech. Mag.

The Italian Scientific Association: Meeting at Pisa, October 1st to 15th, 1839.

All the members of the Italian Scientific Association are admitted to the privileges of membership without any pecuniary payment. An open field is granted to them in the sectional meetings of the Association for the com-

munication of their discoveries and observations, constant opportunities are afforded for the encouragement of conversation, and a tribute of respect is paid to a large portion of the members, by the formation of a select society, within the Association, consisting of those individuals who have worked for the advancement of science, and including, at the same time, the members of distinguished scientific societies.

Great praise is due to Prince Charles Bonaparte, aided by several eminent Professors of Pisa and Florence, for their exertions in originating the Italian Scientific Association. These philosophers were fortunate in obtaining the zealous co-operation of Leopold II, the Grand Duke of Tuscany, in the preliminary arrangements for the meeting; and the attendance of that sovereign at the sectional meetings of the Association, and his willing attention bestowed on the scientific papers which were read in the various sections, plainly demonstrated the interest which he felt in the proceedings of this society.

On the 1st October, 1839, a religious service was performed in the cathedral at Pisa, to which the Catholic members of the Association were invited. After this service, an introductory meeting of the scientific members was held in the university. On the following day, a beautiful marble statue of Galileo, which had been recently erected in the centre of the court of the university, was exhibited to the members of the Association, and a formal oration was delivered by Professor Rosini of Pisa in honour of Galileo.

The first general meeting of the Italian Association took place on the 3rd of October, and Professor Gerbi, the aged President of the Association, read a long address on this occasion, in which he expatiated largely on the praises of Galileo, and detailed some of the principal advantages of the six sections of the Association. Several letters from the absent friends of the Association were also read at the same meeting, and among these letters, one of the most interesting was from Sir John Herschel.

All the sections were well attended, and the audience appeared interested, and at times greatly delighted, especially during the most animated discussions.

A magnificent dinner was given by the Grand Duke of Tuscany to all the scientific members of the Association on the 10th of October, and about three hundred philosophers sat down to this banquet, at which the Governor of the city of Pisa presided. After dinner, the health of Leopold II, the Grand Duke, was drunk with evident gratification, and verses were recited in well-merited praise of his liberality.

On the 14th of October, the sectional meetings terminated, and on the 15th of October, the last general meeting of the Association was held, when the Grand Duke of Tuscany took his seat at the right hand of the President. Reports were read from each of the sections; the laws of the Association, drawn up by the committee of the presidents of the sections, which formed the governing body of the Association, were declared; and it was announced that the next meeting of the Italian Association would be held, in 1840, at Turin, and that the meeting in the following year, 1841, would take place at Florence.

L. & E. Philos. Mag.

Eccaleobion, or Machine for Hatching Eggs.

Proceedings of the Zoological Society.

June 11, 1839.—Mr. Bucknell exhibited his *Eccaleobion*, or machine for hatching eggs; and having broken eggs in every stage of incubation, explain-

ed the nature and incidents of the process. Mr. Bucknell stated that the period of incubation in the common fowl, which was, on an average, 21 days, sometimes varied from 18 to 24 days, and that he attributed this variation to the mode of keeping, and previous treatment, by which the embryo was injured, either from the heat of the weather, exposure to variety of temperature, jolting in carriage, &c. The young bird was occasionally known to emit a faint chirp even so long as 24 hours before being excluded; and he believed that if this noise was heard on the 18th day the chicken would probably appear on the 19th. From this and other circumstances, such as the common mode of preparing eggs by varnishing, &c., the porosity of the shell, and other similar causes, he concluded that the small globule of air constantly found in eggs, and which he had observed to increase according to the age of the egg, was produced by the air penetrating the substance of the shell and its lining membrane.

The average number of malformations, according to Mr. Bucknell's experience, was not more than five in a thousand; though in Egypt, it was stated, malformations were extremely common in the artificial process of incubation. He attributed this circumstance to an excess of heat, and generally found it to affect the toes and extremities; sometimes also the muscles of the neck. Ibid.

Microscopical Investigations.

A Society has been formed in London designated the "Microscopical Society." Its objects are, to promote improvements in the optical and mechanical construction of microscopes; the reading and discussion of papers, upon new and interesting subjects of microscopical enquiry; the formation of a collection of rare and valuable microscopical objects; and of a library of reference. At the close of the business of the evening, upwards of fifty gentlemen joined the society. The terms upon which members are admited, are one guinea entrance, and a yearly subscription to the same amount. Mag. Nat. Hist.

Notice.

Proposed exchange of Minerals.—The subscriber has recently made a large collection of the minerals of Nova Scotia, formerly discovered by Dr. Jackson and himself, and is desirous of exchanging suits of them for the minerals of other regions, foreign or domestic. The specimens have been selected with great care, are of good size, and generally well crystalized, often uniting in the same specimen several different species. They comprize nearly all the species of the Kouphine spars of Mohs and Haidinger; rhomboidal or uncleavable quartz; most of the varieties of quartz, agate, jasper, amethyst, &c., besides many interesting ores, salts of lime, &c. &c. By referring to the 14th and 15th volumes of Silliman's Journal, or to the 1st volume, new series, of the Transactions of the American Academy, a particular notice of these minerals will be found, in a memoir on the Geology and Mineralogy of Nova Scotia.

Those persons who may wish to exchange are requested to forward to the subscriber, in Boston, a list of such minerals as they may wish to dispose of, before sending the specimens, as his cabinet is already well supplied, and it is his wish to select such, principally, as are not already contained in it.

FRANCIS ALGER.

Boston, Mass., February 1st, 1840.

LUNAR OCCULTATIONS FOR PHILADELPHIA, JUNE, 1840.

Angles reckoned to the right or westward round the circle, asseen in an inverting telescope.
☞ For direct vision add 180° ☜

Day.	H'r.	Min.	Star's name.	Mag.	From Moon's North point.	From Moon's Vertex.
6	10	9	Im. q Leonis	5, 6	37°	84°
6	11	10	Em.		257	307
6	11	22	Im. 76 Leonis	6	12	62
6	12	4	Em.		286	336
9	11	33	N. App. ☽ and 75 Virginis 2′.0	6, ☽ North		
17	13	12	Im. f Capricorni	6	83	65
17	14	27	Em.		329	328
18	12	55	Im. r Capricorni	6	110	82
18	14	19	Em.		306	292

Meteorological Observations for January, 1840.

Moon.	Days	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rises.	Barometer. 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	12	15	30.00	30.00	NW.	Moderate.		Cloudy—clear.
	2	6	18	.00	.00	W.	do.		Clear—do.
⊗	3	9	20	29.95	29.90	W.	do.		Partially cloudy—clear.
	4	16	26	.90	.92	W.	do.		Partially cloudy—do. do.
	5	18	27	.94	.94	W.	do.		Clear—do.
	6	23	33	.94	.94	W.	do.		Cloudy—do.
	7	23	31	30.00	30.03	E.	do.	.06	Snow—Clear.
	8	18	33	.00	.01	W.	Calm.		Lightly cloudy—do. do.
	9	24	35	.00	29.95	W.	do.		Clear—do.
	10	22	37	29.85	.83	W.	do.		Clear—do.
	11	30	40	.80	.76	S.E.	Moderate.		Cloudy—do.
☾	12	19	21	.90	30.10	N.E.	do.	.04	Snow—clear.
	13	18	31	30.00	29.87	W.	do.		Snow—cloudy.
	14	29	37	29.75	.65	W.	do.	.01	Cloudy—do.
	15	31	27	.55	.60	W.	do.		Cloudy—snow.
	16	7	12	.80	.90	W	do.		Clear—do.
	17	1	11	30.05	30.05	W.	do.		Clear—do.
☉	18	5	17	.05	.05	W.	do.		Clear—do.
	19	10	22	.15	.08	W.	Brisk.		Clear—do.
	20	19	39	29.95	29.95	W.	Moderate.		Clear—do.
	21	30	42	.80	.93	W.	do.	.97	Cloudy—do.
	22	30	33	.90	.80	E.	do.		Snow—rain.
	23	33	32	.20	.43	W.	Brisk.		Clear—do.
	24	14	20	.95	30.00	W.	do.		Clear—do.
	25	10	20	30.18	.30	W.	Moderate.		Clear—do.
☽	26	9	19	.45	.45	W.	do.		Clear—do.
	27	23	30	29.80	29.80	S.E.W.	do.		Cloudy—do.
	28	24	30	.80	.60	E.	do.	.14	Snow—cloudy.
	29	30	37	30.00	.86	E.	do.		Drizzle—do.
	30	40	49	29.50	.40	S.	do.		Rain—cloudy.
	31	27	29	.95	30.00	W.	do.		Clear—Partially cloudy—aurora.
	Mean	20.32	28.23	29.91	29.90			1.20	

	Thermometer.		Barometer.	
Maximum height during the month.	49.00	on 30th.	30.45 on the 20th.	
Minimum " "	1.00	17th.	29.20 "	23rd.
Mean	24.28.		29.905	

METEOROLOGICAL REPORT

FOR THE STATE OF PENNSYLVANIA,

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

APRIL, 1840.

	County.	Town.	Observer.	Thermometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Register. Lowest.	Mean.	Days omitted.	Barometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.
1	Philadelphia,	Philadelphia,	J. M. Hamilton,	59.95	69.93	63.47	82.	51.00	64.45	12	34.00	45.74	3	30.27	30.26	30.26	30.63
2	Montgomery,																
3	Bucks,	Newtown,	L. H. Parsons,	51.27	63.60	49.48	84.	31.75	54.78	.	27.00	42.48	.	30.06	30.00	30.01	30.45
4	Lehigh,																
5	Northampton,	Easton,	Lafayette College,														
6	Monroe,	Stroudsburg,	A. M. Stokes,	45.75	61.35	46.07	86.	28.00	51.06	10	....	....	.	....	....	....	....
7	Pike,																
8	Wayne,																
9	Susquehanna,	Silver Lake,	E. W. Rose,	40.43	57.37	45.27	84.00	26.00	47.69	.	22.00	36.13	.	28.06	28.04	28.07	28.90
10	Luzerne,	Wilkesbarre,	W. F. Dennis,														
11	Schuylkill,																
12	Berks,	Reading,	C. F. Egelmann,														
13	Chester,																
14	Delaware,	Haverford,	Haverford School,														
15	Lancaster,	Lancaster,	Conservatory of Arts,	49.97	64.57	53.57	81.50	32.00	56.04	$\frac{2}{3}$	30.00	45.37	.	29.61	29.58	29.57	30.00
16	York,																
17	Lebanon,																
18	Dauphin,																
19	Northumberland,	Northumberland,	Andrew C. Huston,	50.15	60.37	51.78	79.00	32.00	54.10	.	24.00	40.57	.	29.53	29.48	29.48	29.90
20	Columbia,																
21	Bradford,																
22	Tioga,																
23	Lycoming,																
24	Union,																
25	Mifflin,																
26	Juniata,	Mifflintown,	J. A. Rinkead,	43.18	62.73	54.69	81.00	26.00	53.53	1	....	....	.	29.55	29.53	29.50	29.90
27	Perry,																
28	Cumberland,	Carlisle,	Prof. W. H. Allen,	49.17	61.97	51.43	80.00	31.00	54.19	.	27.00	44.00	.	29.45	29.39	29.40	29.81
29	Adams,	Gettysburg,	Prof. M. Jacobs,	40.68	55.33	46.98	82.00	31.50	47.67	$3\frac{1}{3}$	26.00	42.13	2	29.45	29.42	29.43	29.84
30	Franklin,																
31	Huntingdon,	Huntingdon,	Jacob Miller,	46.	64.10	52.10	83.00	30.00	54.07	$\frac{1}{30}$	....	....	.	29.42	29.36	29.39	29.73
32	Centre,	Bellefonte,	John Harris,	43.48	60.63	49.73	79.00	23.00	51.28	$2\frac{2}{3}$	....	....	.	29.33	29.31	29.31	29.67
33	Potter,																
34	M'Kean,	Smithport,	Richard Chadwick,	41.33	58.47	42.10	86.00	24.00	47.30	.	18.00	36.30	.	28.09	28.10	28.14	28.32
35	Clearfield,																
36	Cambria,	Ebensburgh,	Richard Lewis,	42.43	58.11	44.93	77.00	27.00	48.49	$1\frac{2}{3}$	25.00	38.55	19	27.86	27.86	27.85	28.11
37	Bedford,	Bedford,	Samuel Brown,	47.76	63.49	53.62	86.00	29.00	54.96	.	....	....	.	29.29	29.23	29.27	29.57
38	Somerset,	Somerset,	George Mowry,	46.78	56.61	47.62	76.00	27.00	50.34	$1\frac{1}{3}$	24.50	41.27	.	28.06	28.01	28.09	28.18
39	Indiana,	Indiana,	Richard White,	59.87	63.60	46.53	90.00	31.00	56.67	.	....	....	.	28.65	28.63	28.64	28.90
40	Jefferson,	Rose Cottage,	C. C. Gaskell,														
41	Warren,	Warren,	R. Brown,	45.26	63.	46.07	89.00	20.00	51.44	1	....	....	.	28.94	28.92	28.95	29.75
42	Venango,	Franklin,	Wm. Connely,	38.97	64.	50.70	92.00	18.00	51.22	.	....	....	.	....	29.09	....	29.98
43	Armstrong,																
44	Westmoreland,																
45	Fayette,	Uniontown,	J. P. Weithers,	50.70	62.47	55.33	84.00	29.00	56.17	$\frac{1}{3}$	23.00	31.40	25	29.04	28.99	29.02	29.30
46	Green,																
47	Washington,	Cannonsburg,	Jno. H. Kennedy.	44.83	64.83	53.03	86.00	25.00	54.23	.	25.00	43.20	.	29.11	29.08	29.10	29.37
48	Alleghany,																
49	Beaver,	Beaver,	Wm. Allison,	48.41	64.54	50.62	86.00	27.00	54.52	2	....	....	.	29.44	29.35	29.44	29.76
50	Butler,	Butler,	Jacob Mechling,	46.60	61.80	54.60	84.00	23.00	54.33	.	....	....	.	28.92	28.90	28.92	29.15
51	Mercer,	West Greenville,	S. Campbell,	48.47	61.07	52.14	78.00	29.00	53.89	$\frac{2}{3}$	29.00	45.66	1	28.71	28.71	28.75	28.99
52	Crawford,	Meadville,	J. Limber,	50.97	60.03	51.50	86.00	31.00	54.17	.	26.00	42.57	2	28.75	28.74	28.73	29.03
53	Erie,	Erie,	Park & Reid,	48.13	53.07	47.32	74.00	28.00	49.51	$\frac{2}{3}$	19.00	37.68	.	29.47	29.48	29.46	29.86

LUNAR OCCULTATIONS FOR JUNE, 1840.

Day.	H'r.	Min.	Star's name.
6	10	9	Im. q Leonis
6	11	10	Em.
6	11	22	Im. 76 Leonis
6	12	4	Em.
9	11	33	N. App. ☽ and 75 Virginis 2′.0
17	13	12	Im. f Capricorni
17	14	27	Em.
18	12	55	Im. r Capricorni
18	14	19	Em.

Meteorological Obse

Moon.	Days	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rises.	Barometer. 2 P.M.	Direction
				Inch's	Inch's	
	1	12	15	30.00	30.00	NW
	2	6	18	.00	.00	W
⊗	3	9	20	29.95	29.90	W
	4	15	26	.90	.92	W
	5	18	27	.94	.94	W
	6	23	33	.94	.94	W
	7	23	31	30.00	30.03	E.
	8	18	33	.00	.01	W
	9	24	35	.01	29.95	W
	10	22	37	29.85	.83	W
	11	30	40	.80	.76	S.E
☾	12	19	21	.90	30.10	N.E
	13	18	31	30.00	29.87	W
	14	29	37	29.75	.65	W
	15	31	27	.55	.60	W
	16	7	12	.80	.90	W
	17	1	11	30.05	30.05	W
☉	18	5	17	.05	.05	W
	19	10	22	.15	.08	W
	20	19	39	29.95	29.95	W
	21	30	42	.80	.93	W
	22	30	33	.90	.80	E.
	23	33	32	.20	.43	W
	24	14	20	.95	30.00	W
	25	10	20	30.18	.30	W
☽	26	9	19	.45	.43	W
	27	23	30	29.80	29.80	S.E.
	28	24	30	.80	.60	E.
	29	30	37	30.00	.86	E.
	30	40	49	29.50	.40	S.
	31	27	29	.95	30.00	W
	Mean	20.32	28.23	29.91	29.90	

	Therm.
Maximum height during the month.	49.00
Minimum " "	1.00
Mean	24.28.

PORT

ANIA,

ee on Meteor-

te of Pennsyl-

Observer.	Thermometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.
Hamilton, .	59.95	69.93	63.47	82.	51.00	64.45	12
Parsons, .	51.27	63.60	49.48	84.	31.75	54.78	.
e College, .							
tokes, .	45.75	61.35	46.07	86.	28.00	51.06	10
Rose, . .	40.43	57.37	45.27	84.00	26.00	47.69	.
Dennis, .							
elmann, .							
d School, .							
tory of Arts,	49.97	64.57	53.57	81.50	32.00	56.04	⅓
C. Huston,	50.15	60.37	51.78	79.00	32.00	54.10	.
kead, .	43.18	62.73	54.69	81.00	26.00	53.53	1
H. Allen,	49.17	61.97	51.43	80.00	31.00	54.19	.
Jacobs, .	40.68	55.33	46.98	82.00	31.50	47.67	3½
ler, .	46.	64.10	52.10	82.00	30.00	54.07	⅛
ris, .	43.48	60.63	49.73	79.00	23.00	51.28	2⅛
hadwick,	41.33	58.47	42.10	86.00	24.00	47.30	.
ewis, .	42.43	58.11	44.93	77.00	27.00	48.49	1⅓
own, .	47.76	63.49	53.62	86.00	29.00	54.96	.
owry, .	46.78	56.61	47.62	76.00	27.00	50.34	1⅓
hite, .	59.87	63.60	46.53	90.00	31.00	56.67	.
kell, .							
.	45.26	63.	46.07	89.00	20.00	51.44	1
nely, .	38.97	64.	50.70	92.00	18.00	51.22	.
thers, .	50.70	62.47	55.33	84.00	29.00	56.17	⅓
nnedy.	44.83	64.83	53.03	86.00	25.00	54.23	.
son, .	48.41	64.54	50.62	86.00	27.00	54.52	2
hling, .	46.60	61.80	54.60	84.00	23.00	54.33	.
ll, .	48.47	61.07	52.14	78.00	29.00	53.89	⅔
.	50.97	60.03	51.50	86.00	31.00	54.17	.
id, .	48.13	53.07	47.32	74.00	28.00	49.51	⅔

nometer.						Barometer.							Weather.							Winds.																Hygrometer			
			Register.																																				
	Mean.	Days omitted.	Lowest.	Mean.	Days omitted.	7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Clear.	Cloudy.	Days omitted.	Rain.	Snow.	Rain and Snow.	Thunder Showers.	Rain in inches.	North.	N. N. E.	N. E.	E. N. E.	East.	E. S. E.	S. E.	S. S. E.	South.	S. S. W.	S. W.	W. S. W.	West.	W. N. W.	N. W.	N. N. W.	Calm.	Days omitted.	Dew-point.	Days omitted.	Diff. therm. and dew point.	Wet Bulb.
0	64.45	12	34.00	45.74	3	30.27	30.26	30.26	30.63	29.93	30.26	11⅔	15	3⅓	11⅔	....	....	....	..	....	1	⅔	1⅓	⅓	⅔	⅓	1⅓	.	6⅓	⅓	1⅓	.	2	⅓	1⅓	1⅓	.	11⅓	....	.	... .	...
5	54.78	.	27.00	42.48	.	30.06	30.00	30.01	30.45	29.45	30.02	.	15⅔	12⅓	2	....	....	....	..	7.785	.	.	2⅓	.	⅓	.	2⅓	.	⅓	⅔	10⅔	⅓	⅔	⅔	11⅓	.	.	.	....	.	.....	...
0	51.06	10	....	....	.	....	....	....	....	....	...	.	5⅔	13⅓	11	....	....	....	..	.....	3	.	.	1	1	⅓	⅓	.	2	.	5⅔	⅓	3⅔	⅓	5⅔	.	.	6⅔	....	.	.....	...
0	47.69	.	22.00	36.13	.	28.06	28.04	28.07	28.90	27.50	28.06	.	18	12	.	....	....	....	..	2.310	.	.	.	.	.	.	2	.	3	.	5⅓	.	8	.	2⅓	.	9⅓	.	....	.	.....	...
0	56.04	⅔	30.00	45.37	.	29.61	29.58	29.57	30.00	29.08	29.59	⅔	17⅓	12	⅔	8	....	....	1	4.855	3	1	⅓	⅔	1	⅔	3	⅓	5⅔	2	4⅓	1⅓	⅓	1	4⅓	⅓	.	⅔	43.78	3	.....	55.5
0	54.10	.	24.00	40.57	.	29.53	29.48	29.48	29.90	29.13	29.50	.	12⅓	17⅔	.	4	1	....	1	3.263	4⅔	.	1⅔	.	1⅓	.	2⅔	⅓	9⅔	.	2	⅓	2⅔	⅓	3	.	1⅓	.	....	.	.....	50.5
	53.53	1	....	....	.	29.55	29.53	29.50	29.90	29.20	29.53	1⅓	13⅓	14	2⅔	....	....	....	..	4.200	.	.	1	.	⅔	.	2⅔	.	⅔	.	3⅓	.	3⅓	.	4⅔	.	12⅔	1	....	.	.....	....
	54.19	.	27.00	44.00	.	29.45	29.39	29.40	29.81	28.95	29.41	.	14⅔	15⅓	.	5	....	....	3	4.503	⅔	.	1⅔	.	3	.	2	.	2⅔	.	3⅓	.	5	⅔	2	.	9⅓	.	....	.	.....	....
	47.67	3⅓	26.00	42.13	2	29.45	29.42	29.43	29.84	29.12	29.43	3	15⅓	11⅔	3	7	....	1	1	3.943	4⅓	.	⅔	.	⅓	.	⅓	.	5⅓	2⅓	2⅔	.	4⅓	⅔	2⅔	.	3⅔	3	....	.	.....	....
	54.07	⅓	....	....	.	29.42	29.36	29.39	29.73	28.92	29.39	⅔	2	9	.	7	1	....	1	4.108	.	.	.	.	9	.	.	.	.	.	.	.	20⅔	.	.	.	.	⅓	....	.	.....	....
	51.28	2⅔	....	....	.	29.33	29.31	29.31	29.67	28.83	29.32	2⅔	12⅓	15	2⅔	9	1	....	..	1.950	1	.	2	.	.	.	3	.	1⅔	.	10⅓	.	3	.	5⅔	.	⅓	2⅔	....	.	.....	....
	47.30	.	18.00	36.30	.	28.09	28.10	28.14	28.32	27.70	28.11	.	13	17	.	.	.	....	..	2.740	.	.	.	.	4	.	2	.	⅔	.	8⅓	.	9⅓	⅓	4	.	.	1⅓	....	.	.....	57.42
	48.49	1⅔	25.00	38.55	19	27.86	27.86	27.85	28.11	27.41	27.86	1⅔	8⅓	19⅓	2⅓	7	.	....	2	4.144	1	.	⅓	.	1	.	6⅓	.	1⅓	.	3⅓	.	7⅔	.	4⅓	.	3	1⅓	....	.	.....	...
	54.96	.	....	....	.	29.29	29.23	29.27	29.57	28.82	29.26	.	15⅔	14⅓	.	.	.	....	..	.....	.	.	.	.	.	.	3	3⅔	.	7⅓	3⅔	2	2⅔	4	3	⅔	.	.	....	.	.. .	....
	50.34	1⅓	24.50	41.27	.	28.06	28.01	28.09	28.18	27.58	28.05	1	12⅓	16⅔	1	4	1	1	6	4.695	⅓	.	⅔	.	⅔	.	2⅓	.	⅔	.	10⅓	⅓	4	⅔	3⅓	.	5⅓	1	....	.	.....	....
	56.67	.	....	....	.	28.65	28.63	28.64	28.90	28.30	28.64	.	18⅔	11	⅓	9	....	....	..	3.975	.	.	.	.	.	.	2⅓	.	2⅔	.	2⅔	.	5	.	5⅔	.	11⅔	.	....	.	...	....
	51.44	1	....	....	.	28.94	28.92	28.95	29.75	28.50	28.94	1	15⅓	13⅔	1	....	....	...	..	.....	2	.	.	.	⅔	.	.	.	5	.	.	.	5⅓	.	⅔	.	15⅓	1	....	.	....	....
	51.22	.	....	....	.	....	29.09	....	29.98	28.69	29.09	21	.	.	.	....	....	....	..	.....	.	.	.	.	.	.	3⅔	.	.	.	⅓	.	.	.	5	.	.	21	....	.	.....	....
	56.17	⅓	23.00	31.40	25	29.04	28.99	29.02	29.30	28.45	29.02	⅓	20	9⅔	⅓	8	....	1	1	3.562	⅓	.	1⅓	.	.	.	2⅓	.	.	.	14⅓	.	5	.	2	.	4⅓	⅓	....	.	.....	....
	54.23	.	25.00	43.20	.	29.11	29.08	29.10	29.37	28.80	29.10	.	16	13	1	9	....	....	..	2.365	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	....	.	.....	....
	54.52	2	....	....	.	29.44	29.35	29.44	29.76	29.06	29.41	2⅓	12⅓	15	2⅔	8	1	....	..	2.875	⅓	.	2⅔	¼	⅓	.	1½	.	1	⅓	7⅓	⅓	1⅔	⅓	6	.	5	3	....	.	.....	....
	54.33	.	....	....	.	28.92	28.90	28.92	29.15	28.60	28.91	.	.	.	.	7	1	....	..	3.190	.	.	1⅔	.	6	.	2½	.	1	.	6	.	11	.	2	.	.	.	....	.	.....	....
	53.89	⅔	29.00	45.66	1	28.71	28.71	28.75	28.99	28.04	28.72	.	13⅓	16	⅔	8	....	....	..	.....	9½	.	.	.	.	.	⅔	.	13⅓	.	⅔	.	.	.	⅔	.	4⅔	⅔	....	.	.....	48.65
	54.17	.	26.00	42.57	2	28.75	28.74	28.73	29.03	28.33	28.74	.	12	18	.	12	1	....	1	3.028	1⅔	.	.	.	.	.	⅓	1	7⅔	⅔	2⅔	.	4⅓	½	3⅔	½	4⅔	2⅔	....	.	.....	....
	49.51	⅔	19.00	37.68	.	29.47	29.48	29.46	29.86	29.04	29.47	.	12⅓	17⅔	.	6	1	....	..	2.021	2	.	1⅓	.	.	.	.	1⅓	5⅓	⅔	1⅓	⅓	5⅓	1⅓	2	1⅓	7⅓	.	....	.	.....	....

LUNAR	
Day.	H'r.
6	10
6	11
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18	12
18	14

Moon.	Day
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Maximu	
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Mean	